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THE TREATMENT OF PRIMARY INOPERABLE CARCINOMA OF THE BREAST BY RADIATION: A REPORT OF 54 CASES FROM THE BREAST CLINIC[1]

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WITHIN the past decade, radiotherapy has become definitely established as one of the useful methods in the treatment of mammary cancer. Moreover, in the primary inoperable cases, it is now regarded by the profession generally as the method of choice. Surgeons and radiologists are demanding trustworthy data upon the results of treatment of this disease. It is deplorable that premature reports are made, a few months after treatment, of brilliant results of radiotherapy in the field of mammary cancer. Such publications are misleading and tend to throw the science of radiation into disrepute. The present paper is a report of the course and results of the treatment of 54 cases of primary inoperable carcinomata of the breast, admitted to the Breast Clinic at the Memorial Hospital prior to January 1, 1921, all patients having begun their treatment 3 years or more ago.

DEFINITION

The average surgical judgment of to-day places a case of mammary cancer in the inoperable group only in the presence of very advanced disease. Upon the other hand, men of more mature surgical experience look upon a patient as inoperable, when by means of the usual radical operation all of the disease cannot be completely removed. However, there are certain groups which are anatomically operable which invariably do badly if operated upon, and these should also be included in the inoperable class. The cases we have in mind are the so-called inflammatory carcinomata, and carcinomata of the breast in young women, complicating pregnancy.

With these exceptions a primary inoperable carcinoma of the breast may be defined as one in which any one of the following factors is present:

1. Definite fixation of the tumor to the chest wall.
2. Marked involvement of the axillary nodes of the same side as the breast lesion, with extension well up beneath the clavicle.
3. Definite fixation of the axillary nodes to the chest wall. We fully appreciate the difficulty of determining, in certain cases, the exact extent of the axillary involvement. It is well recognized that a fairly extensive metastasis to axillary nodes may not be appreciable by palpation prior to operation.
4. Well marked fullness of the supraclavicular region of the involved side. Almost invariably one finds that such cases, observed from time to time, develop later distinctly palpable nodes in this region.
5. Palpable supraclavicular nodes. A painstaking examination will fre-

[1]Read before the Radiological Society of North America, at Rochester, Minnesota, December, 1923.

quently reveal a small, hard node, directly behind the inner end of the clavicle, and this is often the first supraclavicular node which is palpable.

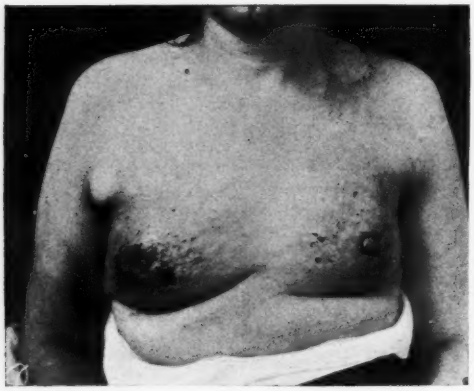

Fig. 1. Inflammatory carcinoma, both breasts.

6. Firm nodes easily palpable in the opposite axilla or opposite supraclavicular space, whose presence cannot be explained by some other pathological condition. Not infrequently cases are encountered with involvement of these nodes without carcinoma in the corresponding breast.
7. Evidence of metastasis in the other breast.
8. Diffuse extensive invasion of the skin with or without cutaneous nodules.
9. Evidence of metastasis to the pleura, lungs or mediastinum.
10. Evidence of metastasis to bones. Occasionally one may find a small tumor in the breast with little or no involvement of the axilla but with evidence of metastasis to bones. A careful clinical history may lead one to investigate radiologically, complaints which seem at first trivial, and thus reveal metastasis to bones.
11. Metastasis to distant organs, liver, brain, etc.

FREQUENCY

Of all primary carcinomata of the breast entering the Breast Clinic at the Memorial Hospital in the year 1920, 61.2 per cent

Fig. 2. Inflammatory carcinoma, right breast (before treatment).

were inoperable. The problem of the care of these inoperable cases is, therefore, apparent. Further, these figures emphasize the need of well-directed efforts along the lines of education and publicity, that the medical profession and, through them, the public, may appreciate the need of a more ready recognition of this fatal disease.

CHARACTER OF THE DISEASE

It is generally recognized that cancer of the breast, in the beginning, is a local disease, which remains localized for a comparatively short period. From this primary focus, there is an early dissemination along lymphatic channels, and usually the earliest metastasis occurs in the axillary lymph nodes. Early distant metastasis in some cases indicates a transmission of tumor cells through the blood stream.

Further, we believe that the term "carcinoma of the breast" really covers a group of diseases, some of which in their early phases exhibit markedly different clinical behavior, and frequently present certain distinct pathological pictures. Although it is impossible, at present, to go very far in

the effort to separate these various groups, we believe that an increase in our knowledge of mammary cancer may enable us later to make further group differentiations. A more thorough recognition of the various types of mammary cancer may lead ultimately to still more logical plans of therapy.

Fig. 3. Inflammatory carcinoma, right breast (3 months after treatment). Same case as Fig. 2.

THE VALUE OF BIOPSY IN THE DIAGNOSIS OF MAMMARY TUMORS

In the large majority of cases of primary inoperable cancers of the breast a correct diagnosis can be made by clinical methods. However, too much emphasis cannot be placed upon the need of careful gentle handling of breast tumors by examining fingers to avoid the danger of dissemination, a point so well demonstrated by Knox (1). Further, it is hazardous for large numbers of people to examine a breast containing a carcinoma, for the purposes of demonstration or teaching. We fully realize that occasional cases of operable carcinomata may not be easily recognized, and in these instances biopsy for diagnostic purposes is justifiable. The objection to biopsy as a means of corroborating the clinical diagnosis is in the fact that it may permit dissemination through severed lymphatics or blood vessels.

In this paper, which is dealing mainly with the treatment of primary inoperable carcinoma, it seems unnecessary to discuss the ordinary clinical manifestations of mammary cancer, or its metastasis to the axilla or supraclavicular space. Having defined our idea of what constitutes inoperability we will consider some of the subjective symptoms, physical signs, and roentgenographic findings, in metastasis to the lungs and bones.

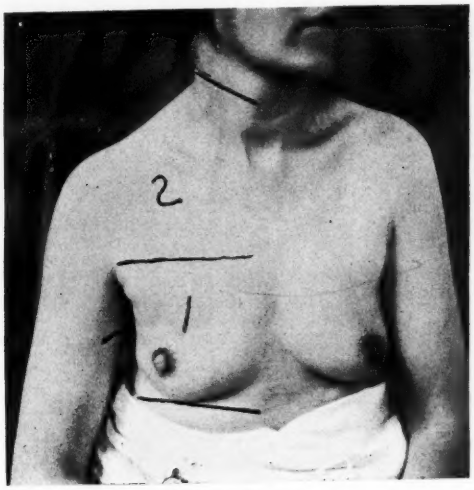

Fig. 4. Areas for X-ray exposure.

CHEST METASTASIS

Metastases to the lungs, pleura, and mediastinum frequently remain unrecognized until the disease in these regions has become advanced. According to Craver (2), physical signs may be elicited which consist in "a peculiar limitation of breath sounds especially marked during inspiration, covering a limited area of the chest. This may or may not be accompanied by fine crackling râles during inspiration or by pleural friction rubs." Later the patient develops definite subjective symptoms, namely, shortness of breath, and a cough, which is dry and hacking in quality, without expectoration. The onset of the cough is frequently sudden (the patient stating that she caught cold on a certain day), and

from that time on the cough and shortness of breath progressively increase. Only in certain cases has hemoptysis been observed.

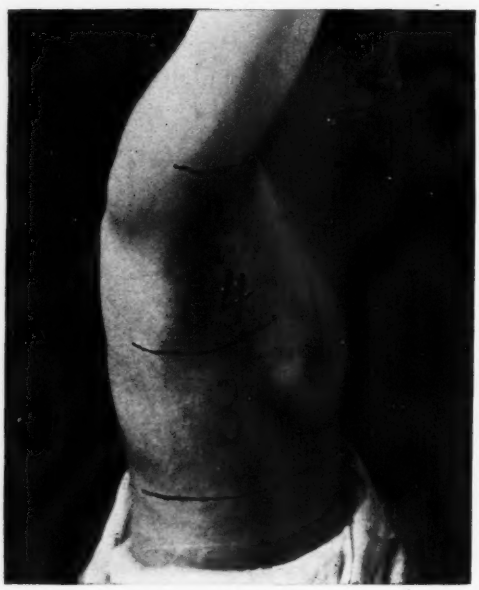

Fig. 5. Areas for X-ray exposure.

Fig. 6. Areas for X-ray exposure.

Radiographic Findings

Frequently, long before any subjective symptoms of metastasis are present, the X-ray plate of the chest will reveal pulmonary involvement. In a small percentage of cases, auscultation of the chest has demonstrated the presence of metastasis, when the X-ray plate was negative or doubtful. It is also true that in a small number of cases the X-ray plate has shown positive evidence of metastasis which was not corroborated by auscultation. The early features of chest metastasis in the X-ray plate are not generally recognized. Often chest plates may be passed as negative where evidence of early metastasis really exists. Many roentgenologists examine such a plate for pronounced shadows, which one seldom sees save in the presence of advanced disease, although the features of early metastasis have been recognized for some time by certain observers. Other authors have stated that they fail to find this picture of early metastasis in the chest. In the larger majority of cases this evidence consists of hazy line-like streaks along the bronchi, extending in a radiating manner from the hilum out into the parenchyma of the lungs. It is usually bilateral and is generally more pronounced upon the side corresponding to the primary tumor. One may also see ill-defined mottling, which in more marked cases gives almost the appearance of miliary tuberculosis. There may also be noted enlargement of the nodes at the hilum of the lungs. There are numerous patients in the clinic showing in the first plate this early picture of pulmonary metastasis, who present in later plates these same findings in a more pronounced form, often associated with definite physical signs. Furthermore, some of the cases coming to autopsy have shown on cross-section of the lungs a diffuse infiltration along the bronchi without bulky tumors, corroborating completely the roentgenographic findings.

The appearance of early chest metastasis is not always sufficiently well marked to warrant a definite differentiation from the fibrotic changes occurring along the bronchi

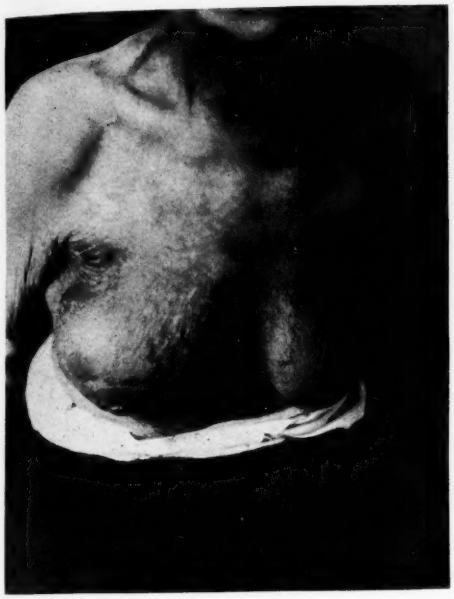

Fig. 7. Case 25, before palliative removal.

after repeated chronic infections, such as recurring attacks of influenza, or chronic pulmonary tuberculosis. As a rule, however, the typical features of tuberculosis and the changes following influenza and other infections are such that in the majority of cases careful study of the plates will establish the diagnosis.

The early recognition of chest metastasis by X-ray examination, even before objective signs are present, is obviously important for the following reasons:

First. It indicates that the disease is beyond the operable stage.

Second. It permits a more rational plan of treatment based upon a knowledge of the extent of the disease.

Unless such an examination is made before operation, an occasional case will be operated upon in the belief that all of the disease can be removed. Under these circumstances radical mastectomy probably shortens the life of the patient, and the chest metastasis goes untreated.

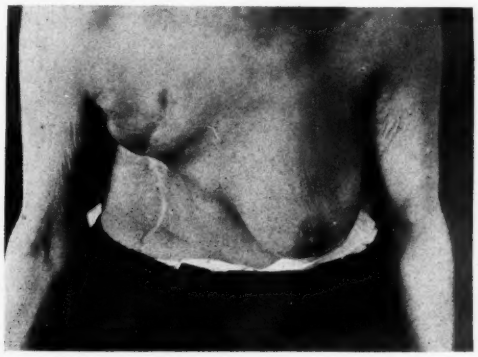

Fig. 8. Case 25, present condition.

METASTASIS TO BONES

This usually occurs later than pulmonary metastasis and is next in frequency. A single bone may be affected or there may be widespread metastasis with involvement of most of the bones of the body. We have encountered the latter condition several times and occasionally only a small tumor was present in the breast. The order of frequency of metastasis to various bones is as follows:

1. The bodies of the vertebræ.
2. The pelvic bones, more often near the acetabulum or sacro-iliac articulations; less often in the ischium pubes, or the body of the ilium.
3. The ribs; usually multiple.
4. The femur.
5. The skull; less often in the humerus and clavicle; very rarely in the bones of the forearm, legs, hands, or feet.

Symptoms of Metastasis to the Bones

1. *Pain.* Pain is an early and almost constant symptom when metastasis to a bone occurs, and frequently is present before an X-ray plate will reveal bone in-

volvement. However, metastasis to the ribs occurs often without any complaint of pain to direct the attention of the surgeon to this region. The need of a careful history and a thorough physical examination in every case of presumable primary operable cancer of the breast is therefore apparent. The patient complaining of lumbago, rheumatism, sciatica, neuritis, etc., should be regarded with suspicion, and examined carefully for involvement of bones. It is not uncommon to see cases with metastasis to bones diagnosed and treated by physicians for rheumatism, the true significance of pain and its relation to the tumor in the breast being unappreciated.

Fig. 9. Multiple metastases throughout pelvis.

Fig. 10. Chest plate (same patient as Fig. 9).

2. *Impairment of function.*

3. *Swelling* at the site of pain which appears later but sometimes persists after pain has subsided.

4. *Tenderness*, which is not infrequently elicited, with or without swelling.

The Appearance of Metastasis on the X-ray Plate

Recent developments in radiography make it possible to obtain plates with fine detail, and therefore the diagnosis of bony lesions in deep-seated parts has been made less difficult.

(A) Metastasis to the Spine

The appearance of metastasis to the body of a vertebra is characterized by a narrowing of the body, frequently with a wedge-shaped appearance and with comparatively little diminution in the width of the intervertebral spaces. Moreover, there is a definite loss of density, and seldom any evidence of bone production.

The most common condition to be differentiated from this form of metastasis is tuberculosis. In tuberculosis one may find the same loss of density but the inter-vertebral spaces are narrowed, and the destruction of bone is characterized by a hazy, ill-defined appearance. When wedging occurs it follows secondarily as the disease invades the body of the vertebra. Bone production and an increase in bone density may be found in long-standing cases.

(B) Metastasis to Other Bones

When other bones are involved the area of bone destruction is irregular in outline but sharply demarcated. The destruction

is complete and seldom is there any indication of attempt at bone production. When long bones are involved the areas of destruction are less often found near the epiphyses.

TREATMENT OF PRIMARY INOPERABLE CARCINOMA

All primary inoperable cases presenting themselves at the clinic are immediately placed in one of two classes: First, the major group comprising those patients in good general condition, with no special degree of anemia, without cachexia, and no marked loss of nutrition; second, the very advanced group, made up of patients in poor general condition, with a fairly marked degree of anemia, cachetic, and with considerable loss of nutrition.

The Very Advanced Cases

Before entering upon a consideration of the treatment of the first group we will briefly outline the management of the very advanced cases. However hopeless the outlook, every reasonable effort should be made to relieve the patient's physical and mental suffering. The relatives or friends are told the true condition of affairs, the patient never. No attempt should be made to do more than relieve suffering, for vigorous treatment of such a patient by radiation may do more harm than good. Another reason why such a case should never be rejected lies in the fact that occasionally a case of this type may give a far better result following palliative radiation than one could hope to obtain when the patient was first seen. Therefore, such a patient should have light radiation, drugs for pain, and social service or nursing care at home. The more serious cases should be placed in institutions where medical care and supervision can be followed through to the end.

Some of the cases of the inflammatory type do very well for a considerable period following appropriate radiation. The report of these advanced cases occurring prior to January 1, 1921, may be found in a previous paper by one of the writers (3).

The Less Advanced Group

For those cases more amenable to treatment a more vigorous type of therapy is planned. One should recognize that he is dealing with a process which is widespread, with metastasis beyond the regional lymph nodes, if not already a constitutional disease.

General Care of the Patient

This is not the least important part of the therapy of this disease. In following out radiation treatment the patient's general nutrition and strength must be continually considered, for over-zealous treatment may be followed shortly by rapid extension of the disease. Particular attention is directed to the patient's nutrition, for only when this is kept at its highest point will radiation give its maximum benefit. A careful weight record is kept, and a liberal diet, rich in carbohydrates and fats, is insisted upon, as far as tolerance will permit. The woman is allowed to be up and about and is encouraged to spend as much time as possible in the open air and sunshine. However, after and during a series of radiation treatments quiet and rest about the house with avoidance of physical fatigue is advised. For the cases with any degree of anemia, hypodermics of iron seem to be of value. The patient's mental attitude should be made as optimistic as possible, and she should be freed from nervous irritation, and encouraged by cheerfulness.

The Treatment by Radiation

Few realize that a well-marked effect will follow the use of a comparatively light dose of X-ray. Many advise the use of radiation as a destructive caustic agent, applying large doses even beyond the limit of skin tolerance. Recent reports in German literature call attention to the dangerous and sometimes fatal results from giving routinely the so-called 100 per cent, or car-

cinoma dose, to the tumor (4). Satisfactory regression can usually be accomplished by a fractional dose method of treatment.

Radiation Changes

The object of treatment is to bring about a certain amount of growth restraint. In addition, actual regression in the breast,

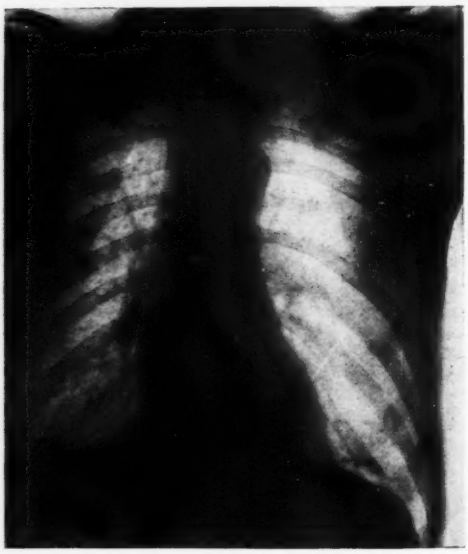

Fig. 11. Early chest metastasis (with rib involvement).

axillary and supraclavicular tumors often occurs. In those patients with pulmonary or bony metastasis, one may ask how much good may be accomplished by the treatment of the primary tumor and axillary and supraclavicular nodes. One is justified in believing that when a large portion of the active disease is made stationary or regressive the patient will be better able to combat the other metastatic lesions. Further, properly radiated tumor tissue is less likely to metastasize. As Ewing has pointed out, sections obtained weeks after radiation show well-marked changes, consisting of an engorgement of blood vessels, a lymphocytic exudate, with hydropic degeneration, and vacuolation of the tumor cells, hyperchromatism of the nuclei, and granular detritus in the connective tissue. At a later date, the blood vessels show an obliterative endarteritis, with marked increase in connective tissue, with a decrease in number or an absence of carcinoma cells.

Moreover, radiation often makes the patient more comfortable, by the relief of pressure symptoms, such as neuritis and edema of the arm. Frequently, ulcerated areas lose their foul-smelling discharge, bleeding ceases, and the ulcer becomes smaller in size, and occasionally closes completely. In some instances, large fungating masses slough away, leaving a clean ulcerating surface, which fills in partially with new epithelium. Such an area may remain quiescent for a considerable period. Ewing interprets the changes noted after radiation as due to the reaction of normal tissues, as much as to the direct effect upon cancer cells themselves (5).

X-ray Technic

One should bear in mind that frequent modifications of technic may be necessary to provide the appropriate dose to meet the special indications in individual cases. The principal variations are in the target skin distance and the length of exposure. Therefore, the decision as to the proper dose cannot be made entirely upon a purely mathematical or physical basis, but always requires clinical judgment born of experience. A series of four or five treatments is given, using the low voltage machine delivering 140 peak K. V. The areas treated are:

1. The breast proper, in front.
2. The breast from the side.
3. The axilla.
4. The upper part of the breast and supraclavicular space.
5. The upper chest posteriorly, radiating also the axilla and supraclavicular regions. A 12-inch target skin distance is used with four millimeters of aluminum filtration, four or five milliamperes of current, a 10-inch spark gap, and an exposure of

15 minutes. This particular set-up has produced certain definite clinical results upon which considerable reliance can be placed in the treatment of a patient with a breast of average size.

With a 12-inch target skin distance and the factors noted above, the intensity of radiation delivered at various depths is indicated on the accompanying table furnished by Failla and Quimby (6):

INTENSITIES OF RADIATION FURNISHED AT VARIOUS TISSUE DEPTHS BY DIFFERENT SOURCES

	Radium		X-rays 300 sq. cm. area on skin	
			30 cm.	50 cm.
Depth	8 × 12 cm. Pack		S.F.D.	S.F.D.
below	6 cm.	12 cm.	4 mm. Al.	.5 mm. Cu.
Skin	from	from	filter, 140	filter, 200
cm.	Skin	Skin	K.V. crest	K.V. crest
0	100	100	100	100
2	68	69	76	94
4	44	46	55	81
7	27	31	36	58
10	17	21	20	39
15	8	11	8	22

It will be seen that at a depth of 7 centimeters beneath the surface, about 36 per cent of the amount given to the skin is delivered. Usually the series of treatments outlined brings about a definite regression in the breast tumor. A repetition of the treatment six weeks later introduces the same amount of radiation, resulting in a still further regression.

The 4 millimeters of aluminum filtration furnishes a homogeneous radiation for all practical purposes when 140 K. V. are employed.

The exposure for 15 minutes gives a well-marked erythema but does not cause desquamation, and can be repeated in three or four weeks without permanent damage to the skin.

The Repetition of the Dose

As long as the tumor continues to regress, further radiation is withheld. Another series should never be given solely because the skin is in condition to stand it. Upon the other hand, a second series of treatments may be given at the end of six weeks if no definite change has taken place in the tumor or it has ceased to regress, and providing the patient's general condition remains satisfactory.

Intervals Between Treatments

Treatments are best given at intervals of two or three days. The patient is less depressed, less nauseated, less disturbed physically and nervously, when this plan is followed. If all these treatments are given, as some advise, at a single sitting, the patient is often made violently ill. The loss of appetite, nausea, vomiting, and fatigue may be so great that she may be very reluctant to return for further treatment. Even when the greatest care is exercised, and the X-radiation given as we have outlined, a certain degree of radiation sickness is to be expected.

The Treatment of Chest Metastasis

This difficult problem is far from solution at the present time, for one is rather reluctant to attempt vigorous treatment of pulmonary metastasis. Though a slight regression might be obtained, there is always the possibility at the same time of seriously impairing the patient's nutrition and general resistance against the disease. Further, the treatment of the breast and drainage areas introduces a very considerable amount of radiation into the deeper tissues of the chest with at least some favorable effect upon the metastasis there. Nevertheless, we are continually making an effort to more adequately treat metastasis in the lung by changes in technic. A few selected cases with metastasis to the lungs have been treated by high voltage without very satisfactory results to date.

Treatment of Metastasis to Bones

Primarily, the treatment of metastasis to bones is for the purpose of relieving pain, for this symptom may be so severe that frequent doses of morphine may be necessary to control it. Metastases to the spine and pelvic bones are usually most distressing to the patient, and, therefore, the ones most

needing treatment. In the majority of these cases a marked relief from pain for a period of several weeks may be expected following a full dose of radiation. Many cases requiring large doses of sedative before radiation have been able to get along with a fair degree of comfort without resorting to drugs or with markedly diminished dosage. In addition to the relief from distressing symptoms, one may expect also a partial regression of the metastatic tumor, with, of course, a cessation of bone destruction. However, metastasis to bones may occur without subjective symptoms, the first evidence of such a metastasis occasionally being a spontaneous fracture or a fracture following a slight injury.

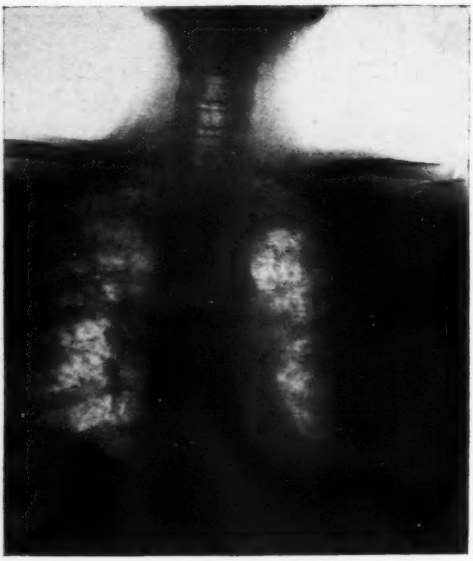

Fig. 12. Chest metastasis (simulating miliary tuberculosis).

With spinal metastasis, the use of a well-fitting plaster of paris jacket, applied after proper radiation has been carried out, renders the patient less disabled, and assists in relieving pain.

High Voltage

A number of cases of primary inoperable carcinoma of the breast have been treated by the high voltage machine with very satisfactory results to date. This is probably due to the character of the cases selected for such treatment, the dosage planned, and the method of its administration. The type of cases chosen for high voltage has been those with large breasts, frequently containing a tumor or tumors deeply situated in the gland. Large fat breasts with diffuse infiltration and the inflammatory type have also responded well to high voltage. However, the employment of the high voltage X-ray has not been the method routinely used in the breast service. From the outset, it has seemed to us that certain disasters would surely follow if heavy radiation with the high voltage machine was made a routine practice in the treatment of carcinoma of the breast. Therefore, we decided upon a fractional dose method in the use of the high voltage. Rarely have we given more than 60- to 80-minute exposures, at one time or in one day. The usual plan in high voltage treatment has been to radiate the entire half of the chest area in three exposures, one from in front, one from the side, and one from behind. The target skin distance is usually 50 cm. with ½ millimeter of copper filtration, 4 milliamperes of current, and 200,000 peak volts, giving a sphere gap of 90 millimeters. With this set-up an 80-minute exposure will give a definite erythema. At a depth of 10 centimeters, 39 per cent of the dose to the skin is delivered. As a rule, three treatments are given at intervals of three or four days. The reaction has been little more distressing to the patient than when the low voltage machine has been employed. In only a few instances has our use of the high voltage machine given results that have not been duplicated in the past by the use of the lower voltage machines. We feel, therefore, that in the treatment of primary inoperable carcinoma of the breast the field of usefulness of the higher voltage method must be a limited one, and that the great majority of cases can be given adequate radiation with the low voltage apparatus.

Radium Treatment

As the therapy and management of primary inoperable mammary cancer has developed, the field of usefulness of radium has become better defined.

Fig. 13. Chest metastasis.

Fig. 14. Advanced pulmonary metastasis.

The Radium Pack

As will be seen in the table on page 129, even the low voltage X-ray machine provides for a larger percentage of skin dose delivered in tissues down to a depth of 10 centimeters than the radium pack at 6 centimeters. Further, when radiating the whole breast and drainage areas, large fields of exposure are necessary, and these cannot be covered by the radium pack, without great loss of time, prohibitive expense and the use of enormous amounts of radium. The only advantage of the radium pack over the X-ray is in the treatment of those cases with small localized and deep-seated lesions. Especially in treating spinal metastasis with considerable pain, a pack of 18,000 millicurie hours at 10 centimeters, with a filtration of 1 millimeter of brass, and $\frac{1}{2}$ millimeter of silver, has proven of value.

Buried Emanation

For the primary tumor itself as well as the axillary nodes, the introduction of radium directly into the tumor gives a large additional amount of radiation without adding greatly to the skin dose or that to the surrounding uninvolved tissues. During the past year, in the treatment of these inoperable cases there has been an opportunity of comparing the results from buried emanation with those obtained by the introduction of radium in needles. This study has led to a much more limited use of bare tubes in dealing with the mammary tumor itself. Experience has shown that the employment of filtered radiation has given more prompt, and frequently complete, regression in the tumor, far less inflammatory reaction, and less permanent fibrosis in and about the tumor. Bagg (7) has shown that the locally destructive effects from bare tube insertion reaches 2 millimeters on all sides of each bare tube, irrespective of the

strength of each tube. An additional zone of inflammatory reaction extends 4 millimeters beyond the zone of necrosis. The zone of effective radiation is therefore 1.2 centimeters in diameter. The main disad-

Fig. 15. Metastasis to left sacro-iliac region and fourth lumbar vertebra.

vantages of buried emanation in the treatment of carcinoma are:

First. The mechanical trauma due to the multiple insertions.

Second. The multiple areas of local necrosis due to beta radiation.

Third. The impossibility of actually placing bare tubes properly spaced throughout the tumor.

Fourth. The degree of regression is apparently less complete. However, a considerable number of cases treated by buried emanation, where a few weak tubes were used, have shown excellent regression over a period of years with no untoward effects.

Radium in Platinum Needles

Before introducing radium into a tumor in the breast or axilla, the cycle of X-ray treatments is completed. The time interval following the last treatment is usually a few days, when the patient has recovered from the general effects of X-ray. The tumor is carefully measured and the cubic contents estimated and a dosage of 25 m.h. per c.c. is given. More recently, a somewhat larger dosage has been employed. The needles used have a steel shank to which is attached a platinum point 4 cm. long with a thickness of .4 m.m. Bare emanation tubes are introduced into the platinum tip and sealed by paraffin. The strength of the radium in each platinum tip has varied from 30 to 70 millicuries. The introduction is always accomplished under local anesthesia. The tumor is divided into fourths from above downward by three imaginary lines and the needles are introduced into the tumor along the two peripheral lines. The needle is, as far as possible, placed transversely from within outward, and equidistant from the anterior and posterior surfaces of the tumor. If the tumor is eight or more centimeters in its transverse diameter, the platinum portions of the needles are introduced so that they will radiate the peripheral half of the tumor. Then at the proper time, the needles are partially withdrawn, providing radiation of the inner portion of the tumor. A similar method is employed in the treatment of the axillary nodes. Smaller and more discrete axillary nodes are more effectually treated by the introduction of bare tubes.

The Palliative Operation

Occasionally one encounters extensive ulcerating breasts, which cannot be completely healed by any type of radiation. In these cases palliative removal may be indicated early or late in the course of treatment. Other cases with a primary regression after a treatment extending over several months may show a breaking down of tumor tissue with subsequent ulceration. In such cases a palliative removal may be done in the best interests of the patient. In the series under report palliative operations were performed upon 9 of the cases, or

18.2 per cent, and 6 of this number are still alive.

Such a removal may be accomplished by means of one of the three methods enumerated below:

1. Surgical Excision.
2. Cautery Removal.
3. Chemical Removal.

Whichever method is selected, the main point to be observed is to make the line of excision well beyond the confines of the breast, thus sacrificing a large amount of skin which may contain invaded dermal lymphatics. Such a wound should be kept surgically clean by Carrel-Dakin dressings, until a healthy granulating surface is obtained. Skin grafting, usually under local anesthesia, closes the wound.

That a comparison of results may be fairly made, we are attempting in the Breast Clinic to try out three methods, hoping that ultimately we may be able to determine the comparative value and disadvantages of these types of removal.

1. The obvious advantage of surgical excision is that it is immediate and skin grafting may be performed at the same sitting. The saving of time to the patient is considerable. Some of the surgical removals have been performed satisfactorily under local anesthesia. The possible danger of dissemination may prove to be a disadvantage of this method.

2. Theoretically, cautery removal seals the lymph channels and blood vessels, but it is less rapid than surgery, and some weeks must elapse before the slough has separated, leaving a healthy granulating surface suitable for skin grafting. Ewing feels that this method is less desirable than the chemical removal, as dissemination is more likely, and the cellular and vascular reaction to heat is feeble.

3. The removal of the breast by the so-called chemical method, using the technic so well worked out by Strobell, has been employed in numerous cases in the clinic. Ewing believes that the inflammatory reaction and thrombosed vessels produced around the area of chemical application form a barrier to the further spread of the disease, and therefore diminish the danger of dissemination. All of us at the Memorial Hospital have been impressed by the results obtained by this method in well-chosen cases, and feel that it has a distinct field of usefulness in the treatment of mammary cancer.

RESULTS

Of the 57 cases of primary inoperable carcinoma of the breast of the less advanced type, which entered the Breast Clinic at the Memorial Hospital up to and including 1920, three left against advice and it has been impossible to follow them. There remain, therefore, 54 patients upon whom a follow-up report can be made. Of this number 10 are alive at the present writing, giving a percentage of 18.5 per cent. In a previous report of one of the writers the numbers of these cases were 8, 9, 25, 26, 32, 33, 46, 47, 53, and 56 (3).

The Average Length of Life of All Patients in the Group

For the entire 54 cases the average duration of life after the growth was discovered was four years. According to Finney, in *Keen's Surgery*, the average duration of life of untreated cases of cancer of the breast is from twenty to twenty-eight months from the beginning of the disease. Therefore, it would seem that the length of life of cases suffering from carcinoma of the breast is materially increased when proper radiation is given.

Of those cases succumbing to the disease it is quite possible that a small number received little benefit from treatment. In a few instances damage done by over-radiation may have added to their suffering and shortened the length of life. Upon the other hand, we feel certain that the figures showing the average length of life to be four years demonstrated that the vast majority of cases were undoubtedly benefited and lived

a year or two longer than would have been possible without radiation. Further, suffering was partially or completely relieved for a considerable period.

Fig. 16. Early chest metastasis (with nodes in right hilum).

Present Condition of the Patients Now Alive

No. 8, A. N., age 65.

Small hard mass right breast, ulcerating, adherent axillary nodes.
Path. type (?).
Chest metastasis—absent at first, now present.
Bone metastasis—absent.
Duration before admission—4 years.
Duration after admission—5 years and 1 month.
Total duration—9 years and 1 month.
Treatment—X-ray and radium (pack).
Course—slowly progressing symptoms.
Result—doing badly, gradual failure of health, confined to house.

No. 9, L. N., age 55.

Large ulcerating tumor, fixed, extensive, axillary nodes.
Path. type (?).
Chest metastasis—present, improved under treatment.
Bone metastasis—absent.
Duration before admission—8 years.
Duration after admission—5 years and 7 months.
Total duration—13 years and 7 months.
Treatment—X-ray, radium (pack and bare tubes), palliative removal.
Course—diffuse cutaneous metastasis.
Result—doing badly.

No. 25, A. S., age 65.

Large ulcerating tumor, large axillary nodes, few supraclavicular nodes.
Path. type (?).
Chest metastasis—absent.
Bone metastasis—absent.
Duration before admission—6 months.
Duration after admission—4 years and 4 months.
Total duration—4 years and 10 months.
Treatment—X-ray, radium (bare tubes—right axilla), palliative removal.
Course—marked continuous improvement in the patient's general condition.
Result—doing well; no evidence of disease to date.

No. 26, E. T., age 78.

Small tumor, fixed to deeper parts, axillary and supraclavicular nodes.
Path. type (?).
Chest metastasis—absent at first, later developed.
Bone metastasis—absent.
Duration before admission—1 year.
Duration after admission—4 years.
Total duration—5 years.
Treatment—X-ray and radium (pack).
Course—did well for a long time, now has diffuse metastases.
Result—doing badly.

No. 32, M. D., age 53.

Large fungating tumor, tumor in opposite breast, large axillary mass, cutaneous nodules.
Path. type—infiltrating carcinoma.
Chest metastasis—absent at first, devel-

oped 2 years and 9 months after admission.
Bone metastasis—absent.
Duration before admission—1 year.
Duration after admission—3 years and 1 month.
Total duration—4 years and 1 month.
Treatment—X-ray, radium (pack), palliative removal.
Course—condition fair, disease not rapidly advancing.
Result—doing fairly well.

No. 33, E. A., age 54.

Large fixed tumor, axillary node.
Path. type—carcinoma simplex.
Chest metastasis—absent.
Bone metastasis—absent.
Duration before admission—2 years and 8 months.
Duration after admission—3 years.
Total duration—5 years and 8 months.
Treatment—X-ray, radium (pack).
Course—marked regression in the tumor.
Result—no evidence of disease to date, doing well.

No. 46, M. M., age 43.

Ulcerated fixed tumor of moderate size, large nodes both axillæ, supraclavicular node.
Path. type (?).
Chest metastasis—pleura involved at beginning of treatment.
Bone metastasis—absent.
Duration before admission—1 year and 3 months.
Duration after admission—3 years and 4 months.
Total duration—4 years and 7 months.
Treatment—X-ray, palliative removal.
Course—thoroughly satisfactory.
Result—no evidence of disease to date, doing well.

No. 47, M. N., age 60.

Adherent breast tumor, small nodes axillary and supraclavicular regions.
Path. type—carcinoma simplex.
Chest metastasis—mediastinal node involved at beginning of treatment.
Bone metastasis—absent.
Duration before admission—4 years.
Duration after admission—3 years.
Total duration—7 years.
Treatment—X-ray, radium (pack, tray, bare tubes, and platinum needles).
Course—disease is advancing slowly.
Result—still in fair general condition.

No. 53, A. R., age 65.

Entire breast infiltrated and fixed, axillary and supraclavicular nodes, arm swollen.
Path. type—alveolar carcinoma.
Chest metastasis—absent.
Bone metastasis—absent.
Duration before admission—1 year and 1 month.
Duration after admission—3 years and 8 months.
Total duration—4 years and 9 months.
Treatment—X-ray, radium (pack, tray, bare tubes).
Course—steady advance of the disease.
Result—poor general condition—patient doing badly.

No. 56, M. S., age 53.

Large mass in the breast, nodes in both axillæ and supraclavicular region.
Path. type—cellular plexiform carcinoma.
Chest metastasis—absent.
Bone metastasis—absent.
Duration before admission—2 months.
Duration after admission—3 years and 3 months.
Total duration—3 years and 5 months.
Treatment—X-ray, radium (bare tubes), palliative removal.
Course—highly satisfactory from the beginning.
Result—doing well, no evidence of disease.

It is interesting to note that of the ten cases living none to date has developed bone metastasis. Three had metastasis in the chest at the time of admission and three

developed metastasis later. One of these showed considerable improvement in the metastasis to the lungs following radiation, as indicated by subjective symptoms and radiographic findings. Four of the ten cases showed neither metastasis to lungs nor bones.

The fact that four of the ten living cases are well, and without evidence of disease three years and more since the beginning of treatment, seems very encouraging. As time goes on, with improvement in technic, one may reasonably expect still better results.

CONCLUSIONS

1. Careful physical and roentgenographic examination is necessary to determine the proper method of treatment.

2. A more strict estimation of what constitutes inoperability should be more generally made.

3. The inoperable cases comprise approximately two-thirds of the primary carcinomata of the breast.

4. Routine biopsy for diagnostic purposes is unnecessary, and may result in a dissemination of the disease.

5. The roentgenographic picture of early chest metastasis is characteristic but is frequently not recognized.

6. Radiation of metastasis to bones usually gives marked relief from pain.

7. The type of radiation and the dosage to be employed can be determined only by a study of the individual patient.

8. The dangers of over-radiation are generally under-estimated.

9. Treatment by radiation lengthens life and relieves suffering.

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THE CLINICAL SIGNIFICANCE AND TREATMENT OF RADIATION SICKNESS[1]

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THE application of massive doses of short wave roentgen and radium rays to patients suffering from deep-seated carcinoma is followed by a complex of acute general constitutional symptoms and localized signs of more or less severity. This observation has been the object of research by many investigators. The symptom complex has been termed by Béclère "radiation indisposition"; by Gauss "radiation kater"; and by the English and the Americans "radiation sickness."

ETIOLOGY

The causes have been variously interpreted. Pfahler (1) attributes the symptoms to poor ventilation of the roentgen ray room, the patient inhaling the ozone and nitrogen which accumulate in the air from the action of the high-tension currents. Scholz (2) and Wintz (3) also assign to these gases a poisonous action.

Lange (4) put forward the view that acidosis develops as a result of cellular destruction. Case (5) found that tests for acidosis proved negative. Hirsch and Peterson (6) found a disturbance of the acid base equilibrium, and sometimes a slight lowering of the alkaline reserve, manifested immediately after treatment with roentgen rays. Golden (7) did not observe a diminution of the alkaline reserve after treatment with roentgen rays. Cori and Pucher (8) reported in a recent communication that in all cases investigated they found a marked retention of chlorides, a retention far greater than could be accounted for by a possible retention of fluids. Sielmann and Schlagintweit (9), on the other hand, observed that the chloride percentage of the blood is rapidly lowered during radiation treatment.

Another theory is that a toxin is produced in the blood by the rays and that this toxin is responsible for the roentgen ray sickness. (Linser and Sick (10), Engel (11), Joltram and Benard (12).)

Linser and Heller (13), Warthin (14), Rosenstein (15), and others have explained the symptoms upon a basis of nephritis caused by the roentgen rays. Krause and Ziegler (16), Buschke and Schmidt (17), Hall and Whipple (18), could not find evidence of nephritis following roentgen ray treatment.

Autolytic ferments present in tissues under normal conditions have been thought by some observers to be accelerated in their action as a result of radiation. (Baerman and Linser (19), Rosenstein (20), Edsall (21).) The part played by ferments in the radiation sickness must remain an open question. There is not sufficient experimental evidence to warrant a conclusion to be drawn at this time.

Warren and Whipple (22) reiterate their experimental data that the intestinal epithelium is peculiarly sensitive to the short wave roentgen rays. It is probable that the intestinal epithelium is at least as sensitive as the skin epithelium. These authors also point out the fact that the clinical intoxication and the progressive disintegration of the killed intestinal epithelium ran a parallel course, and they reason that the clinical intoxication was due to roentgen ray injury of the intestinal epithelium. Martin and Rogers (23) produced severe intestinal changes with a "dog erythema" X-ray dose consisting of hyperemia, marked contraction in all directions, and destruction and desquamation of the mucosa. Bloody diarrhea, ulceration, perforation and stenoses in patients subjected to ultra-deep therapy for abdominal tumors may be due to direct intestinal injury. Behne (24) made pharmacotoxicologic investigations. Guinea pigs were exposed to measured doses of X-rays. The serum of such animals proved to be toxic to the gastro-intestinal mucosa of control animals. He concludes that the biologic action of X-rays is twofold: the primary reaction caused by the formation in the blood of a toxin which is the consti-

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tutional radiation intoxication and the secondary reaction evidenced by local injuries of organs and tissues exposed to rays.

The well-known decrease in the number of white blood cells, especially the lymphocytes, after treatment with roentgen rays has been connected in some way with radiation sickness. Giraud, Giraud and Parès (25) have recently shown that the leukopenia does not follow the radiation of an organ (spleen) that has been clamped off from the circulation, but leukopenia ensues as soon as the clamps are removed and the blood of the treated organs is allowed to flow into the systemic circulation. The sensitiveness of the white blood cells, lymphocytes and leukocytes, is not limited to roentgen rays. These are probably the most responsive cells in the body, as Leo Loeb (26) has recently stated: "They are the finest reagents for the discovery of what we have called syngenisio- and homio-toxins."

Cellular destruction follows exposure to X-rays. The split proteins give rise to an acute intoxication. Numerous observations point to the increased protein metabolism as shown by the increased amount of protein derivatives in the urine. Hall and Whipple (27) observed in dogs after massive doses of roentgen rays that the non-protein nitrogen of the blood was markedly increased a short time before death. The urinary nitrogen also increased and remained high until the death of the animals. These authors conclude that the roentgen ray intoxication or general constitutional reaction is a good example of a "non-specific" intoxication. Hirsch and Peterson (28) could not demonstrate a striking or consistent alteration in the urea nitrogen, total non-protein nitrogen, uric acid and creatinin in blood of carcinoma patients treated with roentgen rays. Cori and Pucher (29) found an increase in the total nitrogen in all cases in the post-radiation periods. It is very probable that a great part of this increase of total nitrogen was due to elimination of destroyed cells. They state that roentgen sickness is not due to excessive cell catabolism.

About fifty consecutive cases with various pathological conditions were treated by me with measured doses of radium or X-rays, or a combination of the two. In conjunction with Drs. Arnold and Brody the blood of these patients was subjected to careful chemical analyses which included the determination of the non-protein nitrogen, urea, creatinin, uric acid, rest nitrogen, chlorides and sugar (30). The blood was taken from the arm-vein one and two days before radiation, twenty-four hours after the beginning of treatment, the day after cessation of treatment and four to six weeks afterwards. The results were reported at the 1923 meeting of the American Association of Gynecologists, Obstetricians and Abdominal Surgeons. The percentage of chlorides was increased in a few of the cases. The sugar values did not show any changes. The observations on the nitrogen constituents were as follows:

Clearly inoperable cervical carcinomata with extensive invasion of the surrounding tissues and necrosis in the tumor show severe symptoms of intoxication following radiation treatment. The non-protein, urea and rest nitrogen were 40 to 55 per cent higher than before treatment. (See Table I.)

In a group of early neoplastic growth with little or no evidence of degenerative changes, slight intoxication was noted after radiation and the nitrogen fractions before and after treatment did not show a marked change. The fluctuations are within normal limits. (See Table II.)

In another group of cases of bleeding uteri and myomata the radiation dose applied was small as compared to that used for treatment in malignancy. The nitrogen fractions were within normal limits. Intoxication did not follow the treatment. (See Table III.)

Recurrent carcinomata, on the other hand, show little constitutional reaction: the non-protein nitrogen fractions, however, may show marked increase. The terminal

carcinomata, also, show marked increase in nitrogen metabolism, but may not evidence any constitutional reaction.

It seems probable that the radiation sickness is due to an absorption into the circulation of protein liberated by the destruction of cells. It is more marked in persons already in a toxic condition from autolytic processes taking place in the cancer. Such patients are already embarrassed in dealing with an intoxication and, if to this strain is added the metabolic labor of dealing with the complete decomposition of a large amount of broken-down tissue products, the metabolism may collapse, and in consequence signs of severe intoxication appear. (Rolleston (31).)

CLINICAL OBSERVATIONS

The acute symptoms of radiation disease may come on within a few hours or may be delayed for days or even weeks.

The nausea and vomiting attacking the patient at the conclusion of a séance in the roentgen room are of a transitory nature and apparently caused by the surcharges of noxious gases due to the high tension currents. These may be reduced to a minimum by placing the transformer in a separate room and providing ventilation by large suction fans. The inhalation of perfume by the patient is said to be helpful.

We should distinguish between the symptoms due to the acute constitutional intoxication and those caused by injury of the tissues and organs exposed to the rays, which are inflammatory. Since we confine our observations mostly to the treatment of pelvic carcinomata the injuries were observed in the small intestines, the sigmoid, the rectum and the urinary bladder, though we have treated also a great number of breast and stomach cancers. The early symptoms are due to the intoxication; the late symptoms to the inflammation.

We, therefore, divide radiation disease into two groups: *(a)* the radiation intoxication and *(b)* the radiation cystitis, proctitis and enteritis—collectively radiation inflammation.

The Radiation Intoxication

The symptoms are anorexia, nausea, vomiting, diarrhea, rise in temperature, increase in pulse rate and marked prostration. The sooner the symptoms appear after radiation the stormier will be the course of the intoxication. The more delayed the onset is, the milder the symptoms will be. The symptoms are toxemic and mainly gastro-intestinal. Clinical observations justify the statement that radiations of the abdomen are more frequently followed by toxemic symptoms than of other regions of the body. Desjardins (32) rightly states that radiation of the upper abdomen is particularly liable to be followed by acute symptoms. We have seen death follow radiation of pelvic tumors as well as of tumors of the breast and the neck. In such cases the symptoms of toxemia increase progressively and rapidly. The fatal termination ensues within three to seven days.

Prophylaxis

The chemical analyses of the blood and the clinical observations permit the following deductions: (1) Patients with carcinomata free from necrosis and of limited extent, termed localized and borderline cases, may be safely given the total radiation dose within the shortest time practicable. (2) Patients with extensive and necrotizing carcinomata evidenced by secondary anemia and marked cachexia, should be treated with fractional doses at selected intervals. We may apply at the first course a dose which will arrest the hemorrhages and the necrosis and temporarily stem the growth of the carcinoma. As soon as the patient has passed the period of radiation intoxication the balance of the radiation dose may be applied. We thus ameliorate the danger of the radiation intoxication and reduce the symptoms below the danger point. (3) Patients with extensive carcinomata almost filling the small pelvis or having large necrotizing areas and advanced cachexia should not be subjected to a full course of radiation treatment. We should

be content to arrest the bleeding with a small dose of filtered radium. (4) Recurrences occurring after the application of a correctly measured and full radiation dose should not be re-treated. The tissues are now refractory to the rays and have lost their reparative powers. Ulceration and necrosis of the normal tissues often follow the re-application of radiations.

TREATMENT

The intoxication should be treated symptomatically. Elimination of the toxic proteins may be stimulated by diuresis and catharsis. Plenty of fluids should be given. Castor oil is the preferred cathartic. Rest in bed, hydrotherapy for hyperpyrexia, nourishing liquid food by mouth or rectum are necessary. Acidosis requires alkalinization with solutions of sodium bicarbonate or hypodermoclysis with normal saline and glucose solutions. Alkalinosis may be treated with mild acids, as orange and lemon juice. The nausea and vomiting may be controlled with large doses of bismuth subnitrate. The latter also counteracts the profuse diarrhea.

Should the symptoms become alarming then hypodermoclysis of normal saline solutions is indicated. Extreme cases require transfusions of whole blood.

A persistence of the toxemia and a concomitant rapid loss of weight and strength also demand transfusions of whole blood. The intravenous injections of colloidal metals are beneficial. They are followed by rigor, pyrexia and leukocytosis, that is, a non-specific reaction. Whether it is caused by the metal or the protective colloid cannot as yet be answered. We observed that patients with a persistent toxicosis and lack of evidence of local healing improved after repeated injections of colloidal metals. The blood count returned to normal, local healing ensued, and weight and strength returned. "Radiation cachexia" is probably a radiation intoxication with a persistent and chronic course.

Radiation Inflammation

The epithelial lining of the urinary bladder and bowels is very sensitive to radiations. The radiation dose for the degeneration or destruction of a carcinomatous growth is very high and we must expect injuries of these epithelial tissues. We may apply a radiation dose of 150 per cent E.S.D., that is, an estal dose, to the mucosa of the bladder and rectum without causing permanent injuries provided we never reapply even a smaller dose of radiation before the expiration of at least twelve to eighteen months. In more than 2,500 cases of deep-seated carcinomata we have not observed a permanent injury if we measured the radiation dose and did not repeat the treatment.

The vesical and rectal mucosa evince the changes as early as eight to ten days following the radiation treatment, but they may be delayed to twenty-one days. They may last from three to six weeks, depending on the intensity and dose of the radiation. The degree of severity of these changes may also be influenced by an idiosyncrasy; however, this is seldom observed.

Cystitis

The symptoms of the radiation cystitis are frequent and painful urinations and in severe cases vesical tenesmus. On cystoscopic examination an intense deep red discoloration and edema of the mucosa are seen. Ulceration and bleeding have not been observed in our clinic.

Keeping the bladder empty during the course of treatment by the insertion of a retention catheter may prevent radiation cystitis. Hyoscyamus, belladonna, sodium bicarbonate, lithium salts, and so forth may relieve the symptoms. The daily application of infra-red rays for two four-hour periods may give relief when all else has failed.

Radiation Enteritis and Proctitis

The symptoms consist of frequent diarrheal stools composed of mucus and at times an admixture of blood. The diarrhea may be excessive and involuntary. Tenesmus is

the most distressing symptom. The endoscopic examination of rectum and sigmoid reveals congestion and edema and later on loss of the superficial epithelium and at times ulceration of the mucosa.

The patient may be placed in a modified Trendelenburg position to displace the small bowel upward and out from the radiation field. The bowels and rectum should be emptied with castor oil and enemas and kept empty during the days of treatment. Liquid diet free of any residue must be given. The vagina should be distended with gauze sponges during the radium treatment, to keep the anterior rectal mucosa far away from the radium capsules. Repeated applications of radium and X-rays even in comparatively small doses will cause contraction and stricture of the bowel, while a single, though large, dose will not terminate in a permanent injury.

The treatment consists of starch enemas preceding and following each bowel movement. The rectal injection of 120 c.c. of olive oil, to be retained during the night, the oral administration of 60 c.c. mineral oil in 60 c.c. cream on retiring at night are very useful. The addition of opium to the enemas is necessary in severe cases.

The diet should be milk, strained gruels, brown flour soup, egg-albumin and jellies. Meat, vegetables and fruit must be avoided. The mucous discharges from the rectum and vagina may cause an excoriation of the skin and the application of Dodd's lotion will afford relief.

CONCLUSIONS

1. The chemical analyses of the blood and the clinical observations of patients treated with radiations permit the statement that the proteins liberated by the action of rays cause an acute constitutional intoxication. This is severest in patients in whom autolytic processes from extensive and necrotic cancers are already existing. The trauma from the rays in the tissues and organs within the radiation field results in an inflammation.

2. Radiation sickness should be divided into primary and secondary forms. The primary form is the acute constitutional intoxication and appears soon after the treatment. The secondary form consists of the trauma caused by the rays in the tissues lying within the radiation field and is an inflammation. It occurs within fourteen to twenty-one days after the radiation.

3. The clinical picture and the prophylactic and curative treatment of the radiation intoxication and inflammation have been discussed. The method of application of the treatment should be based on the clinical findings. Reapplications of modern massive short wave length radiations should not be made, as thus permanent injuries in the form of indurations and ulcers are caused.

TABLE I

	Before treatment		12 to 18 hours after		Average increase in percentage
	Variations	Average	Variations	Average	
Non-protein Nitrogen	21.0—34.7	26.7	33.8—40.2	37.8	42%
Urea Nitrogen	10.0—17.1	13.6	17.6—21.2	19.1	40%
Rest Nitrogen	3.6—13.0	8.8	9.4—15.6	13.7	55%

All figures represent milligrams per 100 c.c. whole blood.

TABLE II

	Before treatment		12 to 18 hours after		Average increase in percentage
	Variations	Average	Variations	Average	
Non-protein Nitrogen	32.6—42.3	36.0	42.3—68.4	47.1	33%
Urea Nitrogen	17.4—20.4	19.2	20.0—39.6	25.4	32%
Rest Nitrogen	6.4—15.5	9.5	15.5—22.1	18.5	96%

TABLE III

	Before treatment		12 to 18 hours after		Average increase in percentage
	Variations	Average	Variations	Average	
Non-protein Nitrogen	20.6—42.9	29.8	24.2—47.3	31.6	+ 6%
Urea Nitrogen	9.8—22.1	14.8	12.6—24.2	16.3	+ 9%
Rest Nitrogen	7.5—15.5	10.7	7.7—16.8	9.2	—14%

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Cumulative Effect of Repeated Exposures.—It is generally accepted that X-ray exposures repeated at short intervals give a summation effect, but the observations are largely concerned with skin injury.

Accurate measurements have been made on the dose necessary for destruction of the mucosa of the small intestines in dogs. From experiments performed by dividing the maximum sublethal dose in dogs, it was found that the ordinary cumulative effect noted in skin reactions does not apply to depth reactions.

A single large dose of X-rays over the abdomen will cause a definite injury of the mucosa of the small intestine, and the severity of the clinical intoxication seems to parallel this recognizable epithelial injury. This clinical intoxication lasts four to six days, if the X-ray dose is sublethal. Subsequent doses of radiation given with this period of clinical intoxication give recognizable evidence of summation or a cumulative effect.

Small but repeated doses of radiation given within a five- or six-day period will cause practically the same cell injury and clinical intoxication as will a single dose representing the sum of small doses expressed in milliampere minutes. Doses of radiation given at six-day or longer intervals show no evidence of summation.

The reaction of this relatively sensitive intestinal epithelium to radiation may be similar to the reaction of certain deep-lying tumor tissues to X-ray therapy, and our experiments may give information of value to physicians concerned with X-ray or radium therapy.

L. R. Sante, M.D.

The Cumulative Effect or Summation of X-ray Exposures Given at Varying Intervals. S. L. Warren and G. H. Whipple. Jour. of Experimental Med., Dec. 1, 1923, p. 725.

RADIUM AND X-RAY TREATMENT OF ADVANCED CARCINOMA OF THE BREAST PRIOR TO AMPUTATION[1]

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FOUR cases of inoperable carcinoma of the breast will be discussed from the standpoint of the initial response, the gross and microscopic tissue changes, and the treatment. Two of the cases were massive inoperable carcinoma of the breast, the third was an operable primary growth with metastasis to the right and left axillary glands, and the fourth an easily operable primary growth with metastasis to axillary glands, and associated carcinoma of the fundus of the uterus, questionably operable.

REPORT OF CASES

Case 1 (A406833). A woman, aged 48 years, came to the Clinic October 5, 1922, with a large pendulous right breast, massively infiltrated with carcinoma, especially in the upper half. The skin was attached but not discolored. Many axillary and supraclavicular glands were involved on the same side. The general condition of the patient was good. However, chronic rheumatic endocarditis, aortic and mitral regurgitation, and chronic myocarditis, with marked dilatation and hypertrophy were noted. The surgical risk was 2+.

Between October 11 and 17, the surface of the skin overlying the primary tumor, and the right axillary region were exposed to 22,428 mg. hours of radium. Topical applications of radium were applied continuously, two to four applications at a time, until twenty-eight areas were exposed. October 19, following an interval of two days, twenty alloy steel points containing radium sulphate were buried in the tumor and allowed to remain in position for twenty hours. October 23, 24 and 25, the left half of the chest, right and left supraclavicular and left axillary spaces anteriorly, and the posterior chest cavity divided into two equal areas, were all exposed to moderate voltage X-ray treatment. December 6 the patient was in good general condition. The primary mass was markedly reduced in size. The breast was much smaller and softer; the axillary glandular enlargement was not palpable.

A radical amputation of the right breast was performed December 8, 1922. The patient's convalescence and the healing of the wound were uneventful. The pathologist reported two carcinomatous nodules, 4 cm. and 3 cm. in diameter, marked fibrosis and degeneration, and glandular involvement. Between December 20 and 23, and between January 23 and 26, 1923, the anterior and posterior wall of the chest and the right and left supraclavicular and axillary spaces were exposed to moderate voltage X-ray treatment. The patient was in good general health; no palpable nodes were found.[2]

Case 2 (A424868). A woman, aged 47 years, came to the Clinic May 5, 1923, with inoperable carcinoma of the upper half and central part of the right breast. The axillary and supraclavicular glands on the same side were markedly enlarged. The right arm had been moderately swollen for two months. There was chronic mastitis of the left breast with a discharge occasionally.

Between May 9 and 26, the surface of the skin over the tumor, the axilla and supraclavicular spaces, were exposed to 53,322 mg. hours of radium. The application was continuous; two, three and four areas were exposed at one time, except between May 11 and 15. X-rays were applied to the left half of the chest wall, the left axillary and supraclavicular spaces. The posterior chest wall was divided into two equal areas. The posterior cervical region was included in one area.

The patient returned for observation May 9; the primary mass was reduced in size about 70 per cent, and it resembled

[2]January 30, 1924, the patient reports that she is in excellent health.

[1]Read before the Radiological Society of North America, at Rochester, Minnesota, December 3 to 7, 1923.

diffuse fibrosis. The right axillary glands were reduced probably 95 per cent. The right supraclavicular glands could not be palpated. The mastitis in the left breast had diminished, and there was no discharge. There was no swelling in the right arm. The patient's general condition was improved.

A radical amputation was performed August 7. The convalescence and healing of the wound were uneventful. The pathologist reported carcinoma 6 by 3 by 2 cm., with extensive glandular involvement.

X-rays were applied post-operatively to the anterior and posterior chest wall, right and left supraclavicular areas and left axillary space. One X-ray treatment was given by a radiologist near home at the specified time. Some difficulty in breathing was reported; the patient's general health was good.

Case 3 (A423558). A woman, aged 52 years, came to the Clinic April 23, 1923, with inoperable carcinoma of the upper half and central area of the right breast. The skin was attached and erythematous. The axillary glands on the same side were involved. There was a palpable gland in the left axilla and a small indefinite area suggestive of carcinoma in the upper outer quadrant of the left breast. Between April 24 and 29, 17,820 mg. hours of radium were applied to the surface of the skin over the primary tumor and the right axillary space. Two, five and six areas were treated continuously at one time, except during a two-day interval before the twenty steel alloy points were buried into the tumor to remain in position for twenty hours. May 3 the left half of the anterior chest wall, and the right and left supraclavicular and left axillary spaces were exposed to moderate voltage X-rays.

The patient returned for observation July 23; her general condition was improved, and she had gained a little in weight. A definite tumor could not be outlined; only a diffuse fibrotic infiltration was noted in the right breast. There were no palpable glands.

Radical amputation of the right breast was performed July 27. The convalescence and healing of the wound were uneventful. X-rays were applied to the anterior and posterior chest wall and right and left supraclavicular and left axillary spaces. The small tumor in the left breast and the enlarged left axillary gland were still present. November 9, her home physician reported convulsions at night, twitching and jerking of the right side, and a gradual decline in health.[3]

Case 4 (A382270). A woman, aged 50 years, came to the Clinic January 21, 1922, with carcinoma of the right breast easily operable, carcinoma of the fundus of the uterus questionably operable, and adenomata of the thyroid. Other conditions noted on examination were myocardial degeneration with hypertension and aortic sclerosis with aortic regurgitation.

The cancer of the breast was treated with radium to supplement a course of X-ray treatment. Between January 27 and February 2, between February 23 and March 11, between April 12 and 14, and between June 29 and July 4, the anterior and posterior chest walls, right and left supraclavicular and axillary spaces were exposed to moderate voltage X-rays. June 30, five alloy steel points containing radium sulphate were buried in the mass, and allowed to remain in position for fourteen hours. July 9, the original mass was masked by a fibrotic infiltration. There was an enlarged right axillary gland, 3 cm. in diameter, present at this examination.

Simple amputation of the right breast was performed. No surgical difficulties were recorded in the operative notes. The convalescence and healing of the wound were uneventful. The pathologist reported a carcinoma, 4 by 3 cm., involving the nipple.

Between August 1 and 3 the anterior right half of the chest wall, the right axillary and supraclavicular spaces were again exposed to X-rays, a post-operative measure. The patient had improved generally

[3]This patient died January 14, 1924.

and gained in weight. No palpable activity in the field of operation or axilla could be demonstrated. November 3, the patient reported by letter that she felt well except for slight weakness, and continuous moderate sweating.

To complete the record it should be stated that under ether anesthesia the cervix was dilated February 17, 1922, and a large amount of carcinomatous, lumpy material was expelled from the uterine canal. On account of the poor physical condition associated with the carcinoma of the breast, total abdominal hysterectomy was not performed. The pathologist reported carcinoma.

Radium was applied directly into the affected area, using the fractional dose method. Several courses of X-rays were given over the lower abdomen, back, and lateral walls. Exposures were given usually following the treatments of the carcinoma of the breast. The pathologic condition of the pelvis responded very well. The patient has remained free from demonstrable signs and symptoms of activity.

A review of these four cases demonstrates that the primary lesion was markedly reduced in size, and masked in a dense fibrous area. Nearly all of the metastatic tumors were reduced in size, some to such an extent that they could not be palpated. The general health of the patients had improved satisfactorily. A substantial gain in weight and strength was noted. The mental state was changed from anxiety and despondency to hopefulness and determination to regain health.

Many similar observations are recorded in the literature on the favorable influence of irradiation for carcinoma of the breast. Also many important and fundamental studies concerning the gross and microscopic changes in the tissues exposed, and demonstrating convincingly its effectiveness, are recorded.

There is a correlation between the amount and quality of therapeutic rays delivered and absorbed, the influence on the vital processes of the neoplastic cell and its supporting matrix, and the adjacent normal structures involved by the malignant process. This relation is convincingly demonstrated by Alter: "melting" and "acceleration" or "differentiation" are described as occurring in the malignant parenchyma, whereas in the stroma young connective tissue, rich in fibroblasts, wandering cells, and eosinophilic infiltration consisting chiefly of varying numbers of polymorphonuclear cells occur. Later on degenerative changes occur, characterized by fibrosis. The occurrence of the homogeneous hyaline matrix and the eosinophils suggests a long chemical process which affects chiefly the protein metabolism of the cell, "a deep-seated chemical change." Many hundred specimens were studied.

MacCarty studied 218 cases of untreated carcinoma of the breast, and his findings have a direct bearing on the findings of Alter. There is an important feature in the reparative process observed in untreated cases of carcinoma, and mentioned as a possible natural defense mechanism of the body to established cancer. MacCarty designates them as "differentiation," "lymphocytic infiltration," "fibrosis," and "hyalinization." The word "differentiation" designates a specific difference or change in character. One kind of tissue has produced another, which is distinctly unlike the original.

Divided doses of radium cause prickle-cell carcinoma to differentiate, with the ultimate formation of cancroid pearls. The glandular type or adenocarcinoma has been caused to differentiate, with the ultimate formation of simple cysts. This process of differentiation occurs normally in untreated carcinoma although more slowly. As this difference occurs, the rate of cell growth is reduced, thus following the well known unwritten biologic law, that cellular reproduction is inversely proportional to cellular differentiation.

Carcinoma of the breast is not included in Alter's reports. The condition does not permit specimen-taking at frequent intervals as does cervical and rectal carcinoma.

The effects of radium rays on differentiated carcinoma are well shown; for example, adenocarcinoma of the rectum following radium exposures forms cysts with lining epithelium of a benign character. The

Fig. 1. Marked fibrosis and cyst formation, varying in size. The cyst wall shows differentiated epithelial lining. In some areas it is intact, in others it is desquamating and degenerating. Many of the cysts show fibrotic walls and varying amounts of necrotic contents (×30).

functional capacity displaces the multiplying or malignant capacity of the neoplasm.

Lymphocytic infiltration can be found intimately associated with the growth at all stages. Its significance is much discussed. The other changes occurring in the stroma, such as increase in connective tissue, fibrosis and hyalin, furnish material for speculation. Alter cannot find any indications to prove that it is stimulated by radium rays. He says, "Mitotic figures are as rare, if present, as an ordinary granulation fissure." He believes that the process is one of replacement, and may be considered in many respects analogous to the tissue formation during wound healing. The lymphocytic infiltration is no doubt a phase of the replacement process in which the young connective-tissue cells, wandering cells, eosinophils, leukocytes, and so forth are abundantly found in the early stages, with the ultimate production of tissue poor in cellular elements, and finally the more typical degenerative changes such as fibrosis, hyalinization and calcification.

The four specimens removed as recorded in the case reports form the material for this study. No specimens were removed before treatment nor during the interval from the first application of radium until the day of operation. Therefore, all of the features cannot be demonstrated in each case, but by multiple sections and their selection, cellular differentiation, lymphocytic infiltration, fibrosis and hyalinization can be demonstrated.

Broders, who examined the microscopic sections, believes that three of the specimens are of adenocarcinoma; the other specimen was so completely altered that further classification was impossible. Therefore, further differentiation and probable simple cyst formation may be anticipated. Many areas were found convincingly demonstrating this characteristic tissue change, "acceleration" or "differentiation" (Figs. 1 and 2).

The greatest amount of lymphocytic infiltration occurs early in the reaction, although typical areas could be demonstrated, intimately associated with the carcinoma cells (Fig. 3). Fibrosis was the outstanding condition. In many slides it was universal and intimately associated with degenerating carcinoma nests, and in some areas active carcinoma cells were found. Many phases of the degenerating process could be demonstrated. Certain areas were rich in connective-tissue cells (Fig. 4), while others were very poor, consisting chiefly of collagen fibrils, and resembling old scar tissue (Fig. 5). Many fields contained hyalin, a structureless, pink-staining material (Fig. 6). A few areas revealed the characteristic staining qualities of calcium deposits in this hyaline material,

which would indicate a further and definite degenerative process.

It might be stated from this incomplete study that carcinoma of the breast of the adenomatous type can be accelerated or

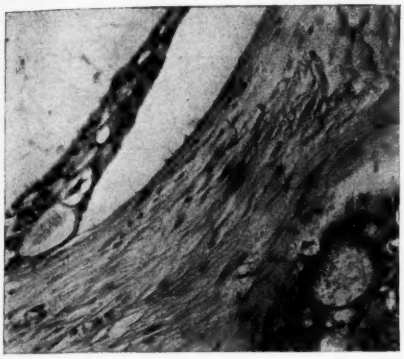

Fig. 2. A higher power magnification of the lesion shown in Fig. 1 (×100). A differentiated epithelial lining benign in character.

caused to differentiate, thus reducing its rate of growth, following its exposure to the rays of radium. It will probably always be a question whether this reaction is direct or indirect. It is a very complex change in which the initial stages are instituted by the radium rays and probably completed by the local and general defensive mechanism.

The changes in the stroma are apparently identical to those found in untreated carcinoma of the breast, and cannot be demonstrated as an etiologic factor. It is probably a defense mechanism or reparative process, and as soon as it has served its purpose of replacing the malignant cell, degeneration occurs.

TECHNIC OF APPLYING RADIUM

The Universal silver tube applicator, with a wall 0.5 mm. thick, containing 50 mg. of the radium element in the form of radium sulphate, filtered through the wall of the applicator, 2.0 mm. of Para rubber and 2.0 mm. of lead, and maintained in one position for from fourteen to twenty hours at a distance of 2.5 cm., is employed. The rubber and lead disk measures about 3 by 2.5 cm. The former is placed beneath the latter and all fixed to the balsa wood block, which is 2.5 cm. thick, and 3.5 by 4 cm. at the base. The radium applicator is strapped on the surface of the lead filter, over which is placed a lead screen, 1.0 mm.

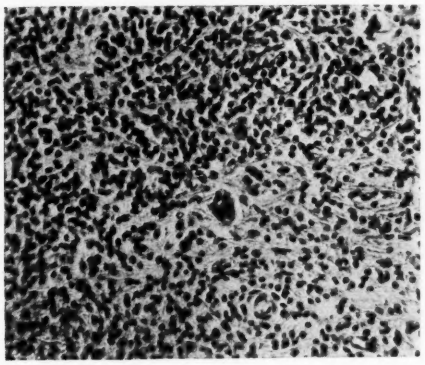

Fig. 3. Lymphocytic infiltration intimately associated with carcinoma cells (×120).

thick by 3.0 by 2.5 cm. Adhesive straps are used to complete the applicator, as well as to fix it in position. The time varies with the number of areas. Should the areas exceed three, the time of application to each area is fourteen hours. The number of areas depends on the amount of skin overlying the lesion. I am gradually increasing the number and extending the areas beyond the involvement for at least a row or two. Each area is about 4 cm. square. The surface of the skin is mapped out with an indelible pencil in checkerboard fashion. This is recorded, and furnishes a satisfactory means of checking the areas exposed, and prevents overlapping and so forth. The surrounding or neighboring skin is protected with large sheets of Para rubber 2.0 mm. thick, and lead sheets 1.0 mm. thick.

Radium applicators were buried in all but one of the four cases, in which a surgical technic as follows was employed: The skin is cleansed with green soap and water, then washed with alcohol (95 per cent). The operative field is swabbed with tincture of iodin (U. S. 7 per cent). The periphery of the mass is divided into quadrants and an incision made in the skin,

slightly larger than the diameter of the radium needle. From four to eight needles are inserted through each skin incision and buried in a radiating manner in one or two planes of the mass, depending on its thick-

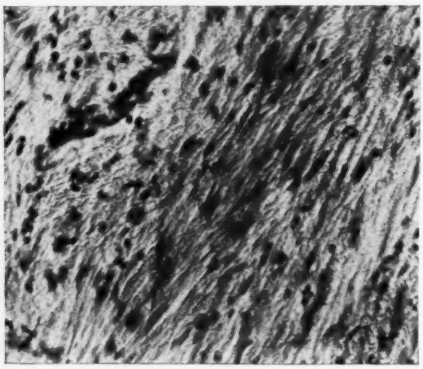

Fig. 4. Fibrous connective tissue fairly rich in cells (×120).

ness. All needles should be implanted in the mass, about 1.0 or 2.0 cm. apart, and at least 1.0 cm. below the upper surface of the mass. The number of needles varies with the size of the mass. The time employed is usually ten to twenty hours. The longer time is employed when the needles are placed well below the surface of the overlying skin. The ordinary steel alloy needle containing 10 mg. of radium element in the form of the sulphate is used. They are sterilized in 95 per cent alcohol for thirty minutes. Ordinary resistance wire is used to withdraw the needle. Umbilical tape is packed into the incision to control the bleeding and retain the points. The free iodin is removed and the wound strapped with narrow pieces of adhesive tape.

One one-hundred-fiftieth grain of hyoscine hydrobromide and one-sixth grain of morphine sulphate are given hypodermically thirty minutes before the implantation. A small skin area, 2.0 or 3.0 cm. in diameter, is infiltrated with 5 to 10 c.c. of a 1 per cent novocaine solution. This combination is usually satisfactory.

TECHNIC OF THE X-RAY TREATMENT

The opposite or uninvolved half of the anterior chest wall, supraclavicular and axillary spaces, and all of the posterior chest wall are exposed to X-rays, using the moderate voltage technic. The following factors were used in the cases reported: In most of the treatments they were nearly constant, that is, 135 kilovolts, as measured between standard spheres, 40 cm. distance, 5 milliamperes of current, and filtration through 6 mm. of aluminum. The time varied: the pre-operative exposure was usually forty-five minutes, while the post-operative exposure was from thirty-five to forty minutes. The size and number of the fields varied. At the first treatment, the anterior and posterior chest walls were equally divided into two large areas, while the supraclavicular and axillary spaces were sufficiently large adequately to expose the surface of the skin. The number of complete treatments varied from two to six, and the usual interval between, from four to six weeks.

REACTIONS

The radium exposures, as outlined, usually produce a first degree of erythema, and in a few, a second degree. This distresses the patient, but it always responds to the application of Dodds' lotion, or simple dusting powders. The general reactions are mild nausea, moderate weakness, and sometimes vomiting. The X-ray may produce a mild degree of erythema, which always responds to treatment. The general reactions are similar to those mentioned under radium, although sometimes they are more severe and prolonged. There seems to be a direct relationship between the general condition of the patient and their production. They are very mild and may be absent if the patient's general condition is good, and the blood picture is normal. They may be very severe if the patient's health has been undermined, and associated with secondary anemia.

DOSAGE

Much has been written concerning the "carcinoma dose," the "sarcoma dose," the "erythema dose," and the "lethal dose." The factors and studies which made these expressions possible have all been exceedingly important. Except in the erythema dose, the patient has been omitted from the consideration, and too disproportionate attention has been given to the type of equipment and its characteristic rays, and so forth. It should be the purpose of the radiotherapist to deliver the quality and quantity of radiation to the lesion that will bring about the melting or hastening effects, and promote the replacement agents, such as the round-cell infiltration, fibrosis and hyalinization. Extensive and tedious studies are indicated, and must be made, to determine the essential factors constituting this most effective treatment.

In my experience the prolonged application to from two to four areas at a time, mapping out practically the entire half of the chest on the involved side, thus providing a large number of areas and employing chiefly Gamma radiation, has been most effective. This provides a fractional dose method which can be easily adapted to the individual variation so essential in determining the necessary dose. Moderate voltage X-ray treatment of the involved side, followed in a few days with the buried radium technic, is equally effective. Post-radium X-ray treatments are essential.

SUMMARY

In untreated carcinoma of the breast, MacCarty has demonstrated a tissue change which may be considered as a natural local defense mechanism, characterized by variable amounts of differentiation, lymphocytic infiltration, fibrosis, and hyalinization.

Microscopically, these changes have been demonstrated by Alter in abundant quantities when carcinoma tissue has been exposed to the rays of radium. The first agent, that of differentiation, is no doubt the primary and most important. When the radiation has been intensive, a rapid change occurs which he designates as "melting," and when the radiation is less intensive, marked stages of differentiation occur which he terms "acceleration." These changes may possibly be influenced by another factor, the tendencies of the tissues to differentiate, once the process has been initiated, possibly by the radium rays. He considers the last three agents replacement factors, and that, when their function is completed, they degenerate.

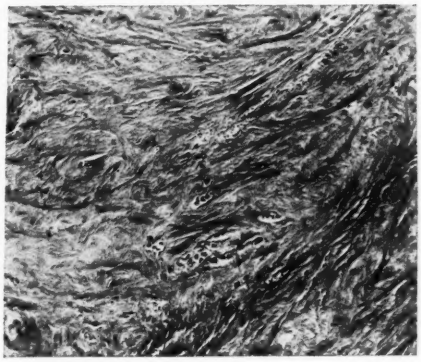

Fig. 5. Fibrotic connective tissue poor in cells and intimately associated with degenerating carcinoma nests.

To-day, radium and X-ray therapy are not competitors of surgery in the management of cases of carcinoma of the breast, although they are an extremely effective adjunct, especially when efficiently applied and when sufficient time has elapsed to ensure their complete effectiveness before operation is undertaken. This may vary from a few weeks to a few months. Owing to the tissue changes, the chance of local recurrence should be nil, and if the condition is local, the chance for cure should be greatly enhanced. The operation, healing of the wound, and surgical convalescence should be uneventful. In short, the time spent in efficient irradiation treatment before operation is not time wasted.

It is highly desirable to know the amount and quality of the therapeutic rays of radium and the X-ray tube sufficient to bring about this deep-seated chemical change, dissolution or differentiation in the malignant parenchyma, together with the

replacement factors so vital to the complete restoration of the part to normal. For the want of a better term, we might designate this the biologic or physiologic dose. It would tend to direct our attention to the patient, which is paramount in our therapeutic management of malignant conditions.

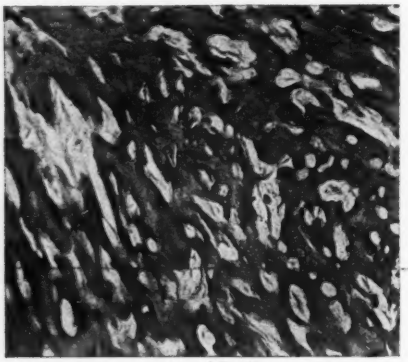

Fig. 6. Hyalin, a pink-staining structureless substance.

CONCLUSIONS

1. Four cases of carcinoma of the breast constitute too small a group to permit conclusions, although it may be said that at least the local, natural defense mechanism against established carcinoma can be produced abundantly in the involved tissue with radium rays.

2. Malignant neoplasms with differentiating tendencies can be made to differentiate further with marked increased rapidity following the application of fractional doses of radium rays.

3. X-rays similar in wave length and frequency to radium rays should be equally effective, producing similar tissue changes.

4. The treatment factors essential to bring about these characteristic and important changes necessitate and demand extensive study and research.

5. It is evident that allowing time for adequate treatment and complete tissue changes before operation should markedly reduce the number of cases of local recurrence, and almost eliminate the possibility of dissemination through the necessary surgical manipulations.

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ROENTGEN TREATMENT OF BREAST CARCINOMATA[1]

By E. L. JENKINSON, M.D., CHICAGO

AS early as 1897, Gocht, Katzenberg and Derks used the roentgen rays in the treatment of breast cancer. Even in the early days, with practically no technic, the older workers claim a number of patients were benefited. During the past twenty-six years, many changes have been brought about both in the character of the equipment and in the methods of administration. Especially during the past three years has our armamentarium been augmented.

With the advent of the large two hundred thousand volt transformers, new stimulus was given the X-ray workers and great improvement in our results was anticipated. The reports from Europe, especially Germany, led us to believe that malignancies of the breast could be favorably combated. Immediately following these very favorable reports there was the usual enthusiasm that is prone to develop even in the most conservative individuals. This great amount of enthusiasm, however, is not to be condemned, as it is only through careful investigation of newer methods that we are able to demonstrate to our own satisfaction whether or not they have merit. If we are phlegmatic and assume an air of indifference toward the new method of treatment, it will be impossible to either commend, condemn or discuss intelligently its possibilities. By neglecting to thoroughly investigate before condemning a method, we are depriving our patients in many instances of that to which they are rightfully entitled. The open mind is to be commended; not too enthusiastic and yet not too conservative.

Surgery of the breast has in all probability reached the point of perfection. The operative technic has been improved from time to time and at present it seems unlikely anything further will be accomplished. The adroit surgeon can remove the breast with very little difficulty. The glands in the axilla and the supraclavicular space can also be removed macroscopically *in toto*. It seems reasonable to assume that a very early lesion confined to the breast can be best treated by surgery. With involvement of the glands in the axilla and supraclavicular space it is doubtful whether surgery offers the patient much chance of a cure. Before subjecting the patient to surgery, it is of utmost importance that a thorough radiographic examination of the lungs, mediastinum and ribs, for metastasis, be carried out. The method of treatment depends upon the results of this examination. If, upon radiographic examination, it is found that metastasis has occurred in the lungs, mediastinum or ribs, it is useless to subject the patient to surgery. The chance of any improvement is very remote, and there is always the possibility of the patient dying during or immediately following the operation. There is a mortality of 1 per cent even in the most skillful hands.

We do not wish to claim that the X-rays will cure carcinoma of the breast. Neither do we advance the opinion that the X-rays should at the present time displace surgery.

The points we are desirous of bringing to the profession are these:

Co-operation between the surgeon and radiologist is one of the most, if not the most, important factor in our present-day battle against malignancies. A closer co-operation of the two will, I am sure, greatly facilitate matters. It is useless for the surgeon to continue to hold himself aloof, dictating the policies to be followed in the treatment of all malignancies. For many years the treatment of breast cancer has been absolutely in his hands, and yet successful surgical treatment averages considerably less than 25 per cent and five-year cures will not average 10 per cent.

Taking these statistics into consideration, is it not fair that radiation be at least given

[1]Read before the Radiological Society of North America, Rochester, Minnesota, Dec., 1923.

a just trial? It should not be the onus of any one branch of medicine to decide individually what shall be done for these patients. I am also referring to the radiologist who treats patients without consultation. It is the duty of every one doing this type of work to get the opinion of a consultant before starting treatment. I am sure there are many cases being radiated that should be subjected to surgery, and there are also many cases operated upon that should be radiated. With closer co-operation the patient will be greatly benefited and possibly cancer of the breast can be favorably combated. To give the patient the best chance for recovery, every scientific method of treatment should be given a fair trial. The surgeon and radiologist should carefully examine the patient and then decide what method of treatment is indicated, or whether a combination of the two is necessary.

Many patients suffering from advanced carcinoma of the breast are sent to the radiologist by the surgeon as a matter of satisfying the patient or her relatives. In many instances the surgeon never sees these patients again, due to the lack of co-operation. Some of these patients respond quite readily to X-ray therapy and may later be referred for surgical interference. It has been the practice of many surgeons to direct the patient to the roentgen department, instructing said patient to tell the radiologist to give her ten minutes' treatment, failing, however, to mention other important factors. The radiologist knows that ten minutes, using certain factors, will cause a severe burn, while with other factors no benefit will be derived. The surgeon prescribing roentgen treatment is not unlike the internist, who, in sending the patient to a surgeon, instructs him to open the abdomen and resect six inches of the bowel, and to use two forceps and complete the operation in five minutes.

The administration of X-rays as a therapeutic agent requires careful study augmented by close observation and experience. To successfully treat a patient, the radiologist must be the judge of what dosage is required. The treatment of breast carcinoma depends upon three factors: The extent of the lesion, the depth of the lesion, and whether or not metastasis has occurred. In the very early lesions confined to the breast, with no apparent lymphatic involvement, surgery in all probability is the method of choice. The chance of cure, however, we believe is augmented by thorough pre-operative radiation. The rays are directed at the breast, axilla and supraclavicular space.

Pre-operative radiation of the breast, we believe, greatly enhances the patient's chance of recovery. Many surgeons object to the procedure, claiming it causes a tardy healing of the wound. We grant this is true, if extremely large doses are used, or if the radiation is carried on over an extended period of time. The resistance of the skin is lowered and endarteritis may follow, which in turn may cause delayed healing, or in some cases sloughing. It is obvious that carrying the treatment to the point of severe reaction in pre-operative radiation is unnecessary. It has been our experience that during the past three years no difficulty in wound healing has been noticed.

It has been very difficult to convince the surgeons that pre-operative radiation is of any value. In fact, many of them look upon it as only a waste of time and money, while others are content to continue as they have been for the past twenty or thirty years. To obviate the necessity of entailing any undue expense, we offer to treat any patient prior to the operation, gratis.

Most surgeons agree that post-operative radiation should be carried out in all cases of breast carcinoma. If the rays will destroy cancer cells in the post-operative case, why will not the same apply prior to operation? By referring the patient for post-operative therapy, the surgeon admits that the rays have some power of cancer-cell destruction. We believe by carefully radiating a breast before operation, many of the cancer cells are destroyed, while others are inhibited. If this is true, the chance of

implantation following operation is greatly reduced. The lymphatics are also blocked, which lessens the chance of cancer cells getting into the lymph stream and metastasis following. The possibility of a defensive enzyme being released during the pre-operative radiation must also be considered. Immunity may play a large part in the successful treatment of carcinoma.

The question is often asked, "How long after radiation shall I wait before operating?" We believe a short period of time should elapse between the radiation and operation; usually a week will allow the patient sufficient time to recover from the general reaction that follows radiation. Our results in cases receiving pre-operative radiation have far surpassed anything we have heretofore obtained. In some fifty cases subjected to this method of treatment, we have not noticed a recurrence. It is true some of the cases are comparatively recent, but we have at present some twenty cases well after two years. (Recurrence, as a rule, usually occurs during the first year following operation.)

In the pre-operative treatment of breast cancer, we have used a comparatively low voltage, as a rule 123,000 volts filtered through six millimeters of aluminum at a target skin distance of sixteen inches. This technic gives an absorption of 58 per cent in the first three inches, using beef for the experiment. The time is varied between thirty and forty minutes. With these factors a skin reaction does not occur.

Before treating a post-operative breast carcinoma, it is essential to first radiograph the chest to ascertain whether or not metastasis has occurred. If, after careful examination, we feel that there is no evidence of metastasis, the patient is treated in the following manner:

A technic is formulated whereby a large absorption coefficient will be obtained in the superficial tissues. During the course of the series, it is very important that the mediastinum be thoroughly radiated. To radiate both the operative field and the mediastinum, it is necessary to use quite different factors. Treatment of the mediastinum calls for deep penetration, while the breast requires comparatively superficial radiation. We have been using the following technic for the past eighteen months, after failing to note any benefit using the very high voltage filtered through one millimeter of copper. For the first series following operation we are using 200,000 volts at a distance of fifty-five centimeters filtered through one-half millimeter of copper. The time is varied from sixty to seventy minutes, or a total of three hundred to three hundred fifty milliampere minutes. With the above factor only a slight tanning of the skin follows. With this technic, an absorption of 58 per cent is obtained in the first three inches of tissue. The anterior field is divided into two areas. Posteriorly, one large area is given, directed at the posterior mediastinum. Following the series, the patient is sent home and is instructed to return in three weeks for a thorough examination with special reference to the skin. At the end of six weeks the patient is told to return to the hospital for further treatment. At this time the technic is changed. The voltage is greatly reduced and aluminum is substituted for copper as a filter. The technic is as follows: 123,000 volts, sixteen-inch target skin distance, six millimeters of aluminum as a filter, five milliamperes for thirty-five minutes. Three areas are given, two posteriorly and one laterally. With the above factors, no skin reaction is obtained. If, however, the time is increased to forty-five minutes, a severe reaction will follow. We have found that the above dose may be repeated in ten days and only a moderate reaction follow. By repeating the dosage in ten days about one and three-fifths times an erythema dose is delivered to the skin with no bad results. The skin reaction usually occurs late. This point must not be forgotten and a third series given inside of three months. If a third series of treatment is given before the lapse of three months, a very serious skin reaction will follow.

Following the treatment, the patient is

instructed to return to the department each month of the first year for examination. During the second year the patient is told to return every three months. During the examination it is always advisable that the surgeon referring the case be present.

The technic mentioned above is not always carried out in the department, as the case at hand may require something entirely different. If, on examination, glands can be palpated, the technic will be entirely changed. It should be the policy of every radiologist to treat the individual case, and there is no exact cancer or sarcoma dose of X-rays. The susceptibility of cancer depends entirely upon the type of cells. In recurrent carcinoma it is imperative that a thorough knowledge of the absorption be known. Many of the recurrences are located in the skin, while others may be an inch below the surface. With the nodules at various depths it may be necessary to use a number of different technics in the treatment. The treatment of breast carcinoma is a very tedious procedure if carried out thoroughly. It may be necessary in many cases to treat groups of nodules individually. This painstaking procedure, however, we feel is well worth the time expended, as it is only through very careful treatment that the patient may be benefited.

ROENTGEN TREATMENT OF PULMONARY METASTASIS

During the past two years, twenty cases showing metastasis into the lungs secondary to breast carcinoma have been treated by the essayist. Our results have been only palliative. None of the cases have shown any great improvement. In some instances the nodules have become smaller, but the patient's general condition became worse and she usually succumbed to the disease in the course of a few months.

One case treated for a period of fifteen months showed marked diminution in the size of the lung tumors. It seemed, however, that we were destroying the tumors at the expense of the host. Following each treatment she was confined to bed, suffering from nausea, vomiting, dyspnea and a very irritating cough. For months after the radiation severe pain in the chest required the frequent use of morphine.

Our methods of treatment have been changed from time to time, hoping we might strike upon some technic or means of application that would at least lessen the pain. We have changed from heavy to smaller doses distributed over a period of several weeks, but at no time did we feel that the patient was benefited. From our experience we feel that patients suffering from metastatic carcinoma of the lungs secondary to cancer of the breast are not in any way benefited by the roentgen rays. We hope, however, that our failure to produce at least temporary relief is due to faulty technic. In the discussion we will greatly appreciate hearing the results of others doing work in this field.

ROENTGEN TREATMENT OF SPINAL METASTASIS

In the treatment of spinal metastasis, in some of the cases showing definite cord lesions we have noted great improvement. Three cases are alive after three years, and are comparatively free from pain and able to walk with no assistance. One of the patients is carrying on her household work. Another patient is at present suffering from severe headaches and on radiographic examination of the skull definite areas of metastasis were found. The pain seemed to be controlled and the paralysis entirely disappeared after the first series.

In the treatment of spinal metastasis we have used high voltage, heavily filtered, ranging from three-quarters to one millimeter of copper. In none of the cases have very large doses been administered for fear of producing skin reaction. If the lumbar region is thoroughly radiated, a severe diarrhea develops, which continues for many months. The diarrhea may be of the recurrent type. For a month the patient may be entirely free from any gastrointestinal disturbance, and then suddenly a

severe diarrhea develops. In our hands the use of tincture of kameria in fifteen minim doses three times daily has been very efficacious. Kameria has controlled the diarrhea after the frequent use of tincture of opium has had no effect.

Results in some of our cases of spinal metastasis have verged on the spectacular, especially those showing paralysis. To see a patient bedridden and completely paralyzed from the waist down with no control of the urine or bowels, get up and walk after a course of treatment, is, to say the least, gratifying. We feel, therefore, that an attempt should be made to treat all these patients, regardless of how hopeless the case may seem.

SUMMARY

1. Co-operation of the surgeon and radiologist is imperative in the successful treatment of breast carcinoma.

2. Pre-operative radiation should be a routine procedure in every case.

3. In post-operative radiation, treat the individual case. Fixed factors are to be discouraged. Formulate a technic conforming to the case at hand. In other words, adapt the technic to the patient and not the patient to the technic.

4. All patients showing spinal metastasis with or without paralysis should be given the benefit of a thorough series of radiation.

Limitations of treatment by radiation.—Radiation therapy in the treatment of cancer at its present status, is, in the opinion of the author, of little use. There is no question but that a long period of careful scientific investigation must precede real advance from the present situation. In general, the limitations of treatment by radiation are in part physical, in part those dependent on the general sensitiveness of the patient to radiation, in part upon the anatomical relation of the tumor, and in part the resistance of the tumor to radiation.

There is no evidence that cancer can be cured, except by a destruction of cancer cells themselves. Connective tissue sclerosis produced by heavy irradiation does not destroy the remaining cancer cells. In all probability, it is merely a question of the amount of energy set free in the individual cell, which determines the lethal action.

The only question with X-ray is to use sufficient voltage to obtain X-rays of such a short wave length that a sufficient dose may be placed in the tissues without excessive skin injury, otherwise there is no advantage in using high voltages. Apparently no especial advantage is gained in practice by the use of voltages over 200,000; many workers are satisfied with 160,000 to 180,000.

All radiologists have observed that certain patients bear radiation badly. In this class of patients efficient radiotherapy is practically impossible.

The third limitation is the site of the tumor in relation to the other important organs of the body.

The fourth limitation lies in the biology of the tumor.

As yet we know little about the radiological biology of human tumor cells. Animal tumors, even where they are of the same morphology, vary greatly in their resistance to X-ray. It has been shown that no matter what form of radiation is used, the same tumor is killed by the same multiple of a skin erythema dose.

L. R. SANTE, M.D.

Limitations in the Radiotherapy of Cancer. Frances Carter Wood. New York St. Jour. of Med., Nov., 1923, p. 446.

MODERN METHODS IN THE TREATMENT OF CANCER OF THE BREAST[1]

By J. THOMPSON STEVENS, M.D., MONTCLAIR, N. J.

STATISTICS

At the present time every one here will probably agree that in the treatment of breast cancer, surgery, roentgen rays, and radium are the methods of choice, also that a combination of these methods or agents will generally produce better end-results than any method or agent, above mentioned, if used singly. This paper is based upon the experience gained in the treatment of 96 cases, of whom 69 were treated by a combination of the above methods or agents, together with 27 cases that, for one reason or other, were treated with radiations alone. Thus far 15 cases are known to be dead, 9 are still suffering with evidence of the disease, while in 2 instances I was unable to get any report whatever. This leaves 70 cases, or 72 per cent, known to be alive and free from all evidence of their disease. Unless the future shows a considerable number of recurrences and metastases causing death, these figures are quite remarkable, especially so, as approximately one-third the cases sent for post-operative radiation therapy, came accompanied by the remark that if I could do nothing for them they were practically sure to go down to death. I am glad to say that about two-thirds of the cases were sent without clinical evidence of the disease, i.e., they were irradiated as a routine from three to four weeks following radical surgical removal of the breast. Nine cases were exposed prior to operation, each case ending in perfect recovery. Twelve of the cases, because of widespread metastasis, were classified as hopeless and were treated for palliation only. The three other deaths were due to (a) pneumonia, (b) fibrosis of the lung, and (c) metastasis to the lumbar spine. These three cases were all irradiated post-operatively, the case developing fibrosis of the lungs showing marked mediastinal infiltration and thickening. Upon roentgen examination, it proved to be presumably malignant in nature, before any radiations whatever were given. The cases that had radiation only can hardly be taken as any criterion for the future, because in all except one, their cases were not proven. This one proven case in this group was a woman who presented a localized growth and who refused both operation and radium implantation, because she was afraid of the radium and because so many of her family had been operated on for cancer, always with failure as a result. Dr. Pfahler saw this patient with me in Boston, in 1921, at which time there were axillary and supraclavicular metastases. Because of fear on the patient's part nothing but roentgen rays of universal tension had been used. Radium implantation and further roentgen ray treatments were advised, all save the roentgen treatments being refused. Death from the disease occurred in a few months' time. Referring to the writings of my former professor, the late Dr. William L. Rodman (1), who says, "I still maintain that surgery should cure one-half of all cases provided that they can be subjected to the complete operation early in the course of the disease," I believe that we are justified in assuming that in this series radiation therapy played a most important part in producing 72 per cent of successes.

PRELIMINARIES TO TREATMENT

Before any treatment is advised or attempted, in addition to a history, general and local examinations, a careful roentgen study of the entire chest should be made, whether the case in hand is to be treated surgically or by radiations or by various combinations of the two. Very occasionally, however, often enough to make the work well worth while, one will discover that a supposedly localized case has already produced metastases, often at considerable distances from the primary focus. In cases showing axillary or supraclavicular metastasis, such examination will show

[1]Read before the Radiological Society of North America, at Rochester, Minnesota, December, 1923.

whether or not the metastatic nodules are all superficial or whether or not there is also metastasis within the chest. These points are of prime importance and must be determined before anything in the way of treatment is attempted. The characteristic of cancer is to grow, slowly in some instances, rapidly in others, producing general carcinosis by metastasis through the lymph system. Eradication of a part of the growth does not cure. How are we to treat the disease if we do not know the location of all of it? A case in point may help to clarify: The wife of one of my very best medical friends had been advised to have both breasts off immediately by a prominent Eastern surgical authority, a man whose surgical word is accepted by every one in my locality. Upon examination I found a tumor in each breast, apparently absolutely operable. Therefore I refused to radiate unless my treatment should be followed by radical surgical removal. Roentgen examination showed a supraclavicular nodule on one side, which was not detected before the roentgenograms were made of the chest and which could not be palpated after the examination. In other words, the gland was too deeply situated to permit of detection from external examination. Dr. Pfahler was again called into consultation and after careful consideration of every detail it was decided to treat the disease with radiations. The supraclavicular nodule, together with the tumors within the breasts, disappeared, this patient now being well three years from that date. Had we been unable to learn that in this case there was a supraclavicular nodule which demanded active radiation, radiation of the breasts alone would have been followed undoubtedly in death by growth and metastasis of the supraclavicular nodule. Surgical removal of the breasts alone, without removal or radiation of the supraclavicular nodule, would likewise have resulted in death.

From what has just been said I feel sure that we are justified in making the statement that it is imperative that a roentgen examination of the chest of every case suffering with malignant disease of the breast be made, together with whatever blood and other tests are indicated in the individual patient, before anything in the way of treatment is advised or undertaken. Nausea and vomiting being very annoying during radiation, patients are instructed to take four drachms of bicarbonate of soda daily so soon as they come under my care. I believe that this treatment of alkalization palliates these symptoms of acidosis.

TECHNIC OF RADIATION THERAPY

No one realizes better than I do, that it is impossible for me to lay down a technic which can be followed blindly in every case. Skilled use of the roentgen rays and radium, to meet the indications in the individual patient, is attained only by those who have had the necessary training that makes for sound radiation judgment. Buildings, equipment, instruments, technic, etc., while each is of great importance, are not the factors which have made this great clinic of the Drs. Mayo and their colleagues possible. The one factor that dominates the whole field is judgment, which came as a result of thorough training, long study, and much practice by each in his chosen field.

In a case being irradiated pre-operative, with a localized tumor, or one that is to be irradiated post-operative that presents no clinical or roentgen evidence of recurrence or metastasis, four ports of entry are taken, one from behind, one supraclavicular, one axillary, and one anterior. Because of several reviews of reports regarding injuries to the pleura and lungs by radiations produced at maximum voltages (I have personally had two such cases, both, however, showing roentgen evidence of disease at the roots of the lungs), the anterior and axillary radiations are given at a lower voltage. It is the radiation absorbed by a part that counts. Therefore, because of the fact that breast cancer is seldom more than 5 cm. below the surface, we can get a sufficient intensity of rays into the breast with a low

intensity in the lung. It is often possible and advisable to divide the breast into two or more ports and by skillful manipulation of the tube and patient, it is possible to deliver a large dose of rays into the breast with very little radiation entering the chest. With high voltage radiation straight through the breast, while the breast receives and absorbs a large amount of radiation, the lungs and pleura also receive a high dose. It was gratifying indeed to learn, last fall, while being entertained in Chicago by Dr. Henry Schmitz, that he had come to similar conclusions. However, for a case showing deep metastasis high voltage radiation must be used in order to reach the disease with a sufficient intensity. Often, to build up the required intensity in the center of the chest it will be necessary to irradiate the entire chest, front, back, and both sides, through the posterior field with the following factors: 4 ma. 220,000 volts, 50 cm. F.S.D., 0.75 mm. cu. plus 2 mm. Al. plus 1/4-inch sole leather filter. One hundred fifty e. units, or three-fourths of my erythema skin dose, is delivered to that skin area, and in the usual case 25 per cent reaches the breast. Then the supraclavicular region, axilla, and breast are irradiated with 4 ma. 134,000 volts, 0.25 mm. cu. plus 2 mm. Al. filter, 50 cm. F.S.D., and time sufficient to give 150 e. units or three-fourths of my erythema skin dose. If, because of the size of the patient, the required intensity has not been obtained, the balance is made up by the use of radium needles. Needles in either 5 or 10 mg. content are buried deep in the tumor, one and two centimeters apart, respectively, and are left in place 16 hours. If irradiated pre-operatively, all but the radium treatments are repeated three weeks after operation; if the radiation was post-operative, a second series is given, after an interval of three weeks.

CONCLUSIONS

1. It is encouraging to review the definite papers on the value and uses of radiation therapy from such surgeons of international reputation as Drs. Charles H. Mayo (2), Howard A. Kelley (3), A. J. Ochsner (4), and others.

2. There is now no just question that can be raised as to the value of radiation therapy when end-results obtained are taken into consideration.

3. Roentgen examination of the chest in every case suffering with malignant disease of the breast should be done before any treatment is advised or undertaken.

4. Technic must be controlled by the conditions present in the individual patient plus an operator capable of meeting the indications.

5. Measurements of radiations with the iontoquantimeter are of great importance. By this method it is possible to repeat our doses at will.

6. While the results obtained by post-operative radiation are a great improvement over those of surgery alone, more can probably be expected by both pre- and post-operative radiation. It has been proven that a properly radiated cancer cell will not grow if transplanted. Some surgeons are making use of this by prescribing pre-operative radiation.

7. From this discussion it appears that a combination of the new higher voltage, shorter wave length roentgen rays, roentgen rays of universal tension, and radium fulfills the conditions better than the treatment by either the "new" or the "old" roentgen rays or by radium alone.

8. The remarks in this paper, while applying especially to cancer of the breast, apply equally to cancer located elsewhere upon or within the body.

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DISCUSSION

Dr. A. W. Erskine (Cedar Rapids, Iowa): There are so many points I should like to talk about and the time is so limited that I can only mention them. Dr. Schmitz's main conclusion that radiation sickness is an intoxication due to split protein, is, I think, absolutely correct. Dr. Schmitz did not mention the fact that there is a great personal variation in susceptibility, and that some patients are able to absorb considerably more poison without symptoms, than others who absorb the same amount, or even less, and are very sick.

Dr. Lee raised the question of low voltage *versus* high voltage. I wonder whether there is any essential difference in the physiological action of short waves and long waves of X-rays. In the treatment of multiple epitheliomata we are able to observe what happens, and if we take the trouble to treat an epithelioma with long waves and another on the same patient with short waves, we will see that the action is the same. Both epitheliomata are destroyed, provided the same amount, if we can speak of an amount of radiation, is given. In several of these papers, it is advised, in order to get a large absorption in the rather superficial structures of the breast close to the skin, that the voltage be reduced from 200 to 125 or 130 kilovolts. I think we can show by charts that we can obtain the same distribution of radiation merely by thinning the filter and letting the voltage stay high. In other words, what the physicists speak of as the "effective wave length" can be increased just as easily by thinning the filter as it can by lowering the voltage, and we will get through with our work in a much shorter time.

Dr. Jenkinson's paper suggests one point that I want to mention and that is: What is the contra-indication to pre-operative treatment? In my own work I think that the contra-indication to pre-operative treatment is an ignorant patient: that is, a patient whose confidence one does not completely have. Every one of us knows that many of these rather large breast tumors will begin to shrink very rapidly after pre-operative treatment, and unless we have a serious talk with the patient before we start to treat her and obtain a promise from her that she will do what we say and what the surgeon says, we had better not treat her, because she will say, "Well, the thing is going away. I am getting well. I am going to stick to X-ray treatment. I am not going to have an operation—I am getting along too well." That will not do, because any of us in the place of these women, knowing what we do about the possibilities of early surgery compared with the radiological treatment that we can give them, would rather have the breast hacked off to-day by next to the worst surgeon in the world than to have the best operation that could possibly be performed six months from now. It is early operation that saves the lives of patients.

Dr. H. J. Ullmann (Santa Barbara, California): I think that the thing that has been brought out by all the papers to-day is the necessity of individualizing the patients and Dr. Schmitz emphasized the value of small doses in individuals who are made sick easily, so as not to kill the patient from roentgen sickness in the hope of killing the tumor. We have lately attempted at Santa Barbara to treat all our patients, so far as possible, without producing severe roentgen sickness, the idea being that the individual who is made very sick will not be in as good a position to combat the tumor which has

not been killed by radiation, as the one who receives less dosage and is at the same time not made sick. We have even gone to the point of treating for only ten to fifteen minutes a day those who have been made very ill by half an hour's dosage. That may seem radical, but I have had some who were pretty sick. In order to combat what sickness does occur, and in the cases where we wish to give a large dosage even to the point of producing sickness, such as in very vigorous young persons with rapidly growing tumors, we have put our patients on the so-called basic diet. The dietitian in the hospital watches the urine daily and regulates the diet so as to keep a normal or slightly alkaline Ph. At the same time they receive not less than 500 c.c. of orange juice. Orange juice has been demonstrated to be one of the best foods we can give to combat acidosis. We can over-alkalinize with soda—don't forget that—and produce an alkalosis, but you cannot do it with orange juice. We have had volunteers at Santa Barbara take the juice of three or four dozen oranges a day, without producing an alkalosis. There is a point in the distribution of prophylactic radiation that is infrequently emphasized, the commonly forgotten area in the epigastric region where metastases pass into the linea alba and down into the abdomen. We think of irradiating the axillæ and supraclavicular regions but we may forget the points lower down.

I would like to ask Dr. Stevens just what he meant by "universal tension"—ray of universal tension?

Dr. Walter E. Sistrunk (Rochester, Minnesota): I have enjoyed very much hearing the papers which have been read this morning and learning the opinion of radiologists in regard to handling patients with cancer of the breast. I think both radium and surgery have a very distinct value in treating cancer of the breast. One of the important questions to-day is just what combination can be used, which will give the best results. I think it is possible that we will eventually improve our present technic in such a way that we will obtain the full value of both radium and surgery.

We all know from the many published reports the percentage of cures which may be expected following surgery in cancer of the breast. This percentage varies in different localities and probably depends somewhat upon the education the public has received in regard to cancer in that particular locality. I heard Dr. Bloodgood make this statement several years ago and I agree with him in believing that the education of the public is a distinct factor in the results which may be obtained in a given community.

There is no doubt that in early cases surgery will effect many cures. There comes a time, however, in each cancer of the breast when the malignant cells metastasize into the glands which drain the breast. I imagine that this occurs from a liquefaction, which takes place in the tumor, and the passage of this fluid through the lymphatics which drain the breast. Unfortunately, we are unable to remove all the lymphatics draining the breast. The vessels which run along with the branches of the internal mammary artery, and those which penetrate into the chest wall, cannot be removed. In all probability the cures which follow the use of radium are obtained in the same group of cases which are cured by operation, and no doubt constitute the group in which treatment is started before glandular involvement has occurred.

My own observation leads me to believe that no particular value comes from radiation when it is followed immediately by surgery. I believe that some patients operated upon shortly after being treated with radium have the operation done with an increased risk on account of the fact that they have been weakened by heavy doses of radium. From my own experience and the results which I have seen through the use of radium, I believe that heavy doses of radium and particularly radium needles, which are buried around and in the growth, will in many cases prevent the further

spread of the cancer, and that when radium has been used in this manner no particular harm will come in delaying the operation until the patient has recovered from the radium reaction, and I feel that eventually we will treat more cases in this way.

It is very interesting to note how similar the changes, which come in the tissues following the use of radium, are to those which MacCarty and others have described in patients who show resistance to cancer. By actual study of the duration of life following operation, MacCarty has been able to show that patients who have marked fibrosis and hyaline tissue formation and leukocytosis in the tissues surrounding the tumor, which is associated with a tendency toward differentiation on the part of the malignant cells, live longer than those without these changes. It seems reasonable to suppose that much of the good which comes from the use of radium may be due to these tissue changes.

In looking back over patients whom I have seen treated with metastases in the abdomen and bones, I can recall no one who has been cured by radiation, and I believe that patients who have already had a spread of the disease to distant points will always die, no matter what type of treatment is used.

Dr. William C. MacCarty (Rochester, Minnesota): I cannot discuss these very excellent papers from a roentgenological standpoint, at least from a technical standpoint. It has been my privilege to study a number of mammary and uterine conditions which have been treated by radium as well as by X-ray. If I were asked to state the principal effects seen in these specimens, I should say, first, destruction of cancer cells and stroma. The destruction is not confined to the cancer cells; it also affects the other tissues, just as would occur after a burn from any other source. The second interesting and, I think, very important thing which we see after radiation following this destruction, is hyalinization of the connective tissue in immediate contact with the destroyed cells. Before we can have hyalinization we must have two things—anywhere in the body: we must have lymphocytic infiltration, then fibrosis, and then the hyalinization. As far as I know, it is impossible to have hyalinization without those two reactions first. In other words, when we study this tissue we find that something has been destroyed and Nature has reacted to this destruction. Apparently these reactions are an attempt at prevention of absorption of the products of tissue disintegration.

A few years ago I was especially interested in post-operative longevity in cancer of the breast, and Dr. Sistrunk and I have published some observations upon this subject. I was interested in trying to find out why certain breast cases, after surgical removal, lived such a long time despite the fact that they had large tumors, extensive involvement of the breast, and involvement of the lymphatic glands. We were frequently surprised to find that these cases lived far beyond our expectation. Such cases were studied in view of four possible factors: the presence of the degree of differentiation of the cancer cells in the breast, because we know that the higher the differentiation of a cell, the less its power of growth. The presence of lymphocytic infiltration in relation to the post-operative length of life, the relation of the presence of fibrosis to this post-operative length of life, and the presence of hyalinization may be seen in the following table (see next page):

I think these figures clearly show that the body has a defensive mechanism against the invasion of cancer cells and that all of these factors play a rôle. The important factors are fibrosis and hyalinization.

Now we must not forget that these, in all probability, are reactions on the part of the individual. They may or may not have anything to do with radiation. The radiation, at least from my present experience, merely produces the destruction. The body has to do its own reacting.

DATA OBSERVED IN THE SERIES OF 293 CASES

Cases	Stomach	Breast	Rectum	Total
	99	92	102	293
Average length of post-operative life	2.62 years	2.5 years	1.47 years	2.19 years
Frequency of differentiation	65 per cent.	8.6 per cent.	86 per cent.	53.2 per cent.
Frequency of lymphocytic infiltration	91 per cent.	60 per cent.	57 per cent.	69 per cent.
Frequency of fibrosis	.....	68 per cent.	75 per cent.	71 per cent.
Frequency of hyalinization	.....	52 per cent.	2 per cent.	27 per cent.
Frequency of differentiation and lymphocytic infiltration	.....	6 per cent.	56 per cent.	31 per cent.
Frequency of differentiation and fibrosis	.....	7 per cent.	70 per cent.	38 per cent.
Frequency of differentiation and hyalinization	.....	4 per cent.	2 per cent.	3 per cent.
Frequency of lymphocytic infiltration and fibrosis	.....	40 per cent.	47 per cent.	43 per cent.
Frequency of lymphocytic infiltration and hyalinization	.....	27 per cent.	1 per cent.	14 per cent.
Frequency of fibrosis and hyalinization	.....	52 per cent.	2 per cent.	27 per cent.
	Years	Years	Years	Years
Average length of post-operative life with differentiation	2.73	3.65	1.54	2.64
Average length of post-operative life without differentiation	2.56	2.37	1.08	2.0
Average length of post-operative life with lymphocytic infiltration	2.73	2.51	1.57	2.6
Average length of post-operative life without lymphocytic infiltration	2.7	2.48	1.31	2.16
Average length of post-operative life with fibrosis	.....	2.72	1.53	2.12
Average length of post-operative life without fibrosis	.....	1.87	1.29	1.58
Average length of post-operative life with hyalinization	.....	2.81	2.33	2.57
Average length of post-operative life without hyalinization	.....	2.21	1.44	1.82
Average length of post-operative life with differentiation and lymphocytic infiltration	2.8	3.78	1.59	2.72
Average length of post-operative life without differentiation and lymphocytic infiltration	1.55	2.45	0.71	1.57
Average length of post-operative life with differentiation and fibrosis	.....	3.87	1.58	2.72
Average length of post-operative life without differentiation and fibrosis	.....	1.96	1.15	1.55
Average length of post-operative life with differentiation and hyalinization	.....	4.0	2.33	3.16
Average length of post-operative life without differentiation and hyalinization	.....	2.04	0.61	1.32
Average length of post-operative life with lymphocytic infiltration and fibrosis	.....	2.69	1.65	2.17
Average length of post-operative life without lymphocytic infiltration and fibrosis	.....	1.4	1.17	1.28
Average length of post-operative life with lymphocytic infiltration and hyalinization	.....	2.76	2.25	2.5
Average length of post-operative life without lymphocytic infiltration and hyalinization	.....	1.68	1.27	1.47
Average length of post-operative life with fibrosis and hyalinization	.....	2.89	2.33	2.61
Average length of post-operative life without fibrosis and hyalinization	.....	2.05	1.28	1.66
Average length of post-operative life with lymphocytic infiltration, differentiation, fibrosis and hyalinization	.....	4.4	2.25	3.32
Average length of post-operative life without lymphocytic infiltration, differentiation, fibrosis and hyalinization	.....	1.52	0.76	1.14

DR. JOSEPH COLT BLOODGOOD (Baltimore): It is important to record first that the results of the surgical treatment of malignant disease are now pretty well established by good records. We have very little evidence that there can be much improvement in the operative technic for the attack on malignant disease. Of course, there is room for improvement for surgeons to become more familiar with, and more expert in, the now well established operative procedures.

The results of X-ray treatment by the older type of X-ray apparatus are about as well established as those of the operative treatment.

Radium, in small doses, for superficial epithelioma and, in larger doses, for cancer of the cervix has been employed long enough to pretty well establish its efficiency and limitations. But radium in large doses for malignant disease has not been employed long enough to justify the conclusion that we yet know its limitations. The same is true of the new and more powerful X-ray apparatus.

Ultimate Results. Treatment is far easier to give than it is to record and to follow up and ascertain with accuracy the real result. There is no doubt, from the older records, that before surgery cancer was treated by caustics and perhaps with the hot iron, and there may have been some cures. Amputation, if the patient survived, undoubtedly cured a few cases of sarcoma of bone, or cancer in an old burn of the extremity. But, for practical purposes, before the days of painless (anesthesia), cleanly and bloodless surgery, malignant

disease, with the rarest exceptions, was practically a hopeless, incurable affliction.

Then came the development of surgery: the better pathology and the more scientific and accurate conception of malignant disease as a local growth with its various possible infiltrations and its metastases.

Halsted's conception of the complete operation for cancer of the breast (excision *en bloc*) dates from about 1886. Billroth's conception of the complete resection of the stomach, from about 1880. However, it is fair to state that good surgery for malignant disease did not begin uniformly until 1890 in a very few localities, and about 1900 to 1905 in many localities.

The ultimate results of this type of good surgery are recorded, published and known throughout the world. The average period in which these patients have been followed is much more than five years, many ten years, a few fifteen years, and even some twenty to twenty-five years.

During the first fifteen years, to 1905, the majority of surgeons were largely concerned with the actual operative treatment and the pathological study of the tissues removed. Anesthesia had to be improved, wound technic was not accomplished until gloves were generally employed (1900), shock had to be eliminated by bloodless surgery (hemostasis) and the careful handling of tissues. There was little time during this period to ascertain results and to study the controllable factors which lead to a failure to cure.

When finally the real results were ascertained, the percentage of cures from surgical intervention was far less than first hoped for, and much less than at first recorded. It was soon apparent that the chief controllable factor in the failure to cure was the known duration of the disease.

More recently a re-study of the actual tissues and sections preserved in many surgical-pathological laboratories, have again decreased the recorded percentage of permanent cures of malignant disease in all localities. What was recorded as cancer in these older records was found not to be cancer.

At the present time it may be stated with fair accuracy, what surgery promises as a permanent cure. These figures are practically identical in all the great clinics in the world: For cancer as a local growth without the involvement of glands 70 per cent and more; for the same type of cancer with the involvement of lymph glands 20 per cent. This is fairly uniform in the tongue, breast, stomach, colon, rectum. It is better in the lip and skin. The probability of a cure after the local removal by amputation or local resection, of sarcoma of bone or soft parts is distinctly less and would average at the present time about 10 per cent.

But these general figures are not the ones to use when we make comparisons of surgical treatment with any other form of treatment. We then must study malignant disease in the different localizations and different stages.

Comparison of Surgical Operation and Radiation. This is difficult. The treatment with X-rays and radium is passing through the same stages as the operative treatment, the stage in which there are many treatments with inaccurate records, often with no pathology, with the diagnosis containing a large element of error, and with an imperfect follow-up. In this stage the large number of apparent cures may be largely explained by inaccurate diagnosis. As in surgery, so in X-rays and radium, in a few clinics the records have been more complete, the diagnosis more accurate, and in these clinics, where the element of error is less, the percentage of cures is always less. This is a very important fact for all of us to bear in mind.

Then, again, the results of surgical operations have often been estimated by local recurrence in the operation wound. This means either late intervention or bad surgery, neither of which ever cures cancer. At the present time, in some localities, we seem to have sufficient evidence which would indicate at once without much doubt,

the choice of the first method of treatment. For this reason it seems wiser to discuss this question under different headings.

Cancer of the Breast. Since our re-study of all the material in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, we have found that the percentage of five-year cures of cancer of the breast without metastasis to the glands is about 70 per cent, varying a little with the different types of cancer. When the axillary glands are involved, the average percentage of cures is about twenty. If only the base glands are involved it is 25 per cent, the mid-glands 20 per cent, the apex glands 10 per cent.

I have been responsible for these figures since 1895. The percentage of five-year cures of the cases with axillary involvement has not varied throughout this period of more than twenty-five years. However, the percentage of permanent cures of cases of cancer of the breast without axillary involvement has changed. The re-study has eliminated 15 per cent as not cancer and has reduced the permanent cures from 85 to 70 per cent.

This should be considered by everyone who is attempting to ascertain whether we ever cure cancer, and if so, by what method.

If we had accepted the written records of this Johns Hopkins clinic and not restudied the sections and tissues, the operative cures of cancer of the breast without axillary involvement, would have been 85 instead of 70 per cent, and this element of error would have rendered it more difficult to study the effect of X-ray treatment after operation.

X-ray and Radium Treatment after Operation for Cancer of the Breast. At the present time I have not sufficient evidence, nor can I get it from my colleagues by conversation or correspondence, nor can I find it in the literature, to allow any definite conclusions. I will record here only what I actually know from my own experience.

In the first place, I wish to warn you against coming to conclusions as to the result of your X-ray or radium treatment, when your records are incomplete and your pathology inaccurate, whether the glands are involved or not, and if the glands are not involved you must be convinced that the tumor of the breast was really cancer. My laboratory contains many records of patients receiving X-ray treatment in which the sections from the primary tumor reveal a lesion which is not cancer.

Local Recurrence. I have one example of a local recurrence living more than five years after a secondary operation, and this recurrent fungous tumor in the scar after the excision of the breast proved to be comedo-adenocarcinoma, the least malignant form of cancer of the breast. Remember, this is the only example of a local recurrence of which I have a record that was cured by surgery, and, strange to say, there is only one cured by X-ray. In this instance the X-rays were given by Dr. MacRae, of Asheville, N. C., and Dr. Kahn, of my office. The apparatus was of the older type, the method, repeated doses. There was no burn. The tumor was a colloid cancer with metastasis to the axilla. The recurrent tumor was in the apex of the axilla. I attempted to remove it, but as it surrounded the vessels and nerves, I could not remove it at all. After the recurrent tumor after my operation became as large as a fist, X-ray treatment was begun. It continued for two years before the tumor disappeared. It is almost five years since the last treatment, and the patient is apparently well to-day. There was no mediastinal involvement.

During thirty years, therefore, there are but two examples of a local recurrence after a complete operation for cancer which have been apparently cured, one in which the local recurrence could be excised, the other in which it could not be excised, but disappeared after X-ray treatment. The pathology in both cases differed from the ordinary scirrhous or medullary carcinoma.

Skin Metastasis. Before X-ray and radium treatment, I never observed a permanent cure when there was skin metastasis at the time of the operation, nor when we per-

formed huge local excisions for skin metastasis after operation. Since we have employed X-rays or radium, or both, I have seen skin metastasis appear near the scar in patients subjected to immediate heavy X-ray treatment directly after operation—the one form of recurrence that we hoped to avert by such treatment. Then, again, I have seen skin metastasis disappear after X-ray and radium treatment.

Mediastinal Metastasis. Patients are returning with mediastinal metastasis who have been given radium or X-rays directly after operation, and patients who are returning with mediastinal shadows suggesting metastasis, have been subjected to deep X-raying without the same definite improvement that we see in lymphosarcoma and Hodgkin's disease.

Conclusions as to X-rays in Cancer of the Breast. As surgery can promise but 70 per cent of cures when the glands are not involved, and 25 per cent, 20 and 10, when the glands are involved, it seems justifiable to give them the benefit of post-operative radiation, and it seems to me that if our records are properly kept and our pathological diagnosis reasonably accurate, we ought to be able to ascertain, especially in the groups in which the glands are involved, whether the X-rays or radium, or both, increase the percentage of five-year cures. My cases have not gone long enough as yet to allow me to reach any conclusions, but I do know that patients subjected to either radium or the X-rays, immediately after operation, are returning with skin metastases, as they did before, in about the same percentage, with mediastinal shadows, with bone metastases, with abdominal metastases. I would like to record that X-rays and radium after operations for cancer of the breast, if they do not add to the permanent cures, at least prolong life and add to comfort, but the actual evidence to support this statement, I am sorry to say, is wanting. Much as I would like to record it, at present it is based upon hope, and not upon fact. The chief hope in my own cases is that the period of time is yet too short to justify the statement that post-operative X-ray or radium treatment offers nothing. There is no question in my mind about its effect in the one colloid cancer which I have recorded, no question as to the disappearance of skin metastasis in a few cases, no question as to relief of pain in some cases of metastasis to the spine.

My own cases have been under treatment by a number of expert roentgenologists. I have examples of all types of X-ray apparatus and of radium.

Should X-ray Treatment be Administered before Operation for Tumors of the Breast? It is fortunate that the great majority of cancers of the breast in which the tumor is clinically benign, is not associated with metastasis to the glands, so these patients have at least a 70 per cent chance of a cure by surgery alone. When the tumor is clinically malignant I am beginning to give X-rays before operation and beginning to feel that this method should be given a distinct trial. But the method of application which I have suggested to Dr. Kahn is somewhat different. I see no profit from wasting radiation on the local growth—surgery can remove it. I want the mediastinum thoroughly gone over. We must recollect the lymphatics passing from the breast into the chest through the intercostal vessels. My evidence suggests that mediastinal involvement is largely through these channels and not through the axilla. The rays, then, must be concentrated upon the apex of the axilla, which is difficult to remove, and not so much upon the base, which is easily cleaned out. One therefore should outline a course of radiation covering these fields. If the tumor is in the lower hemisphere, there must be deep radiation of the chest and diaphragmatic area. Most cases of cancer in the lower hemisphere without metastasis to the glands in the axilla, if not permanently cured, return with abdominal and not chest metastasis. I have often thought of, and frequently practiced, radiation of the skeleton, including the upper end of the femur and pelvis and the upper end of the humerus, but I have

no evidence of its value. At the present moment, as a pre-operative and post-operative measure, I should concentrate upon the areas in the chest and abdomen just mentioned, including perhaps the supraclavicular glands, but paying no attention to the brain, the spine and the skeleton outside of these areas. This method of treatment is based upon the hope that cancer cells or nests which have escaped beyond the field of operation will be destroyed or rendered latent by this pre-operative or post-operative treatment. But as I have tried to impress you throughout, it is a question of records, of accurate bookkeeping and time. We know what surgery has done, now we must try to find out whether this X-ray or radium treatment before or after operation increases the percentage of five-year cures, relieves pain and discomfort, or prolongs life with comfort.

I am inclined to the view that with the present methods and the present evidence we cannot expect much. Remember that the disappearance of the local growth, the disappearance of a skin metastasis, the decrease of the mediastinal shadow, a change in the X-ray picture of a bone metastasis, the temporary relief of pain or paralysis, do not mean that the malignant disease is eradicated.

Method of Application of X-rays and Radium. We constantly hear of the importance of uniform methods of technic. I am rather inclined to urge those using these methods of treatment to try many different methods, with the hope that some one of them will be found to be more efficacious.

The Cure of Cancer of the Breast. At the present time my evidence indicates that to increase the number of cures of cancer of the breast it is necessary to educate women to seek advice the moment they feel a lump in the breast. The chief controllable factor is the duration of the lump, and if this lump be cancer, the earlier it is subjected to treatment, the better the result. When the palpable, definite lump in a woman's breast has none of the definite signs of cancer, the operation should be performed without delay. If the lump is definitely cancer, deep X-ray therapy should be given first. The pre-operative radiation should not require more than seven to ten days, but, of course, this point has not been worked out.

Inoperable Cancer of the Breast. Here there is a great opportunity to try X-rays and radium in different ways, with and without operation. I have been studying primary inoperable cancers of the breast and recurrent inoperable cancers of the breast for twenty-five years. Before the advent of X-rays and radium and before surgery with the electric cautery, incomplete operations with the knife rarely gave any comfort. But since the introduction of the cautery, with and without X-rays and radium, some of these patients have been made more comfortable. This group of patients should grow less as the people receive correct information and as the surgery in the different communities improves. Inoperable cancer of the breast is a disease of ignorance and, as stated before, recurrent cancer of the breast (local recurrence) is due either to ignorance, late surgery, or to bad surgery.

DR. ALBERT SOILAND (Los Angeles): The great outstanding point in this morning's presentation is the apparent fact that radiologists from every section of the country are approaching the same level, are seeking to reach the treatment of cancer of the breast on a common sense, scientific basis. The papers were all excellent. It is very difficult to pick out any one predominating factor for discussion. The question of therapy is that, of course, which interests us. We all agree that surgery for operable cancer is the treatment. The question of pre-operative treatment has not been definitely settled; whether to do it with a prescribed time interval between the pre-operative treatment and the operation is still unsettled. It will take careful observations to settle that question alone. I think we are just as much in doubt as to the length of time a patient should wait be-

tween periods for post-operative treatment. I believe a careful examination, and a general knowledge of the clinical conditions which existed prior to treatment—all those things must be considered before a definite time can be placed upon the number of post-operative treatments.

In regard to the technic, whether or not to use high voltage or low voltage, makes absolutely no difference so long as you give the proper dosage to that part of the tissue where you want to do the work. It would seem good judgment to use a comparatively low voltage on a superficial condition. You can, of course, obtain the same effect with a higher voltage by changing your filter, altering your time element and your distance. In our own place of work we are using the high voltage for the deeper conditions with appropriate elements of filtration. We are more and more coming back to the moderate voltage, if we may call it such, for our breast cases—140 KV. What we want is the energy of radiation, and when we get that in the desired field and in sufficient quantities, we are obtaining all that is possible from radiation.

I think the discussion this morning has taught us that we are reaching a more uniform level, and with the assistance of our good friends, the surgeons, we ought to arrive at a place where we can definitely lay out a combined scientific treatment for cancer of the breast.

Dr. I. Seth Hirsch (New York City): I think that Dr. MacCarty's contribution has been of very great value in directing attention to the influence of the nature of the tumor and its characteristics and its site in the determination of the results obtained with radiation treatment. It seems to me that we need a revision of our viewpoint. Until recently, and perhaps still at the present time, the viewpoint has appeared to be,—to destroy the carcinoma cell. The results of the post-mortem in many of the cases which have been radiated thoroughly from this standpoint show that even where the most intense necrosis has been produced, there are nests of cancer cells in the fibrous tissue bands right in the midst of the areas of necrosis. There is abundance of evidence to indicate that it is impossible to destroy all the cancer cells in a tumor, no matter how long and how intensely the tumor is radiated. Judged from the basis of physical laws and from the basis of the quantum theory, it seems that it would be impossible to do this, and to hit every atom or shoot out an electron from every atom. If you believe that the effect is produced by the Beta radiations generated in the tissue, it is then utterly inconceivable that the atomic structure of every cell should be affected. Now is it necessary that every carcinoma cell should be destroyed in order to obtain a clinical cure? The analysis of tumors which have ever been radiated with this idea of killing every cancer cell—this "knockout-dosage" of our German friends—will show that just in the cases where there has been the maximum destruction of the cancer cells, the reconstructive effort on the part of the surrounding tissue, the reconstructive effects of lymphatic infiltration, the fibroblastic deposit is at a minimum.

The experiments of Murphy and Hussey have shown that heavy X-ray exposure of a mouse tumor made practically no difference in the number of takes after inoculation as compared with inoculations of the half of the tumor not thus treated. Furthermore, grafts from a non-radiated tumor, placed on different areas of the same mouse failed to grow only when the area of inoculation had received previous radiation. These results indicate the importance of the local reaction of the tissues about the tumor. Therefore an examination of the dosage required to depress the vitality of the pathological tissues and to stimulate the defensive powers of the normal tissue is important. Such a dosage will not be found effective for all disease, as both local and general immunity and sensitivity differ in each individual case. Is it not essential that we deliver the radiation with an intent and purpose of depressing the vitality of

the cancer cell, and at the same time stimulating the reconstructive forces and powers of the body, local and general? With this point of view our whole technic of radiation will have to be amended. In fact, there are some statistics from German clinics which I would like to show you, of cases which have been radiated, one group with one dose of weak radiation, one group with several doses of weak radiation and a group with intensive radiation, to show that there is a marked difference in the results obtained.

The new viewpoint should be to keep the patient alive. Treat the tumor but don't forget the host. That is why the work of Dr. Lee is so commendable. Those of you who have read Handley's book on Carcinoma of the Breast will, I believe, agree with me that he proves pretty conclusively that the spread of the tumor occurs by way of the lymphatics; in fact, he even shows that the isolated nodules, found at a distance from the central focus, between which and the central focus there appears to be no tangible connection, were really at one time definitely associated by infiltrated lymphatics, but that the intervening bridge of the lymphatics has been healed by lymphatic fibrosis. He also shows that at a distance of 12 or 15 inches from the central mass, there are infiltrated and diseased lymphatics, not palpable or not discoverable macroscopically, while in the center of the mass of the main tumor there is already considerable degeneration of the cancer cells. Would not these findings indicate a revision of our technic? Perhaps, more important than attacking the central mass, it would be to first attack the lines of invasion at the far periphery, as Dr. Bloodgood has suggested, in the median line, and to the opposite side to the axilla and in the epigastric region. Block off the lymphatics first—then take care of the main mass.

One of the speakers gave as a result of his method of radiation 72 per cent freedom from recurrence in the period of three and a half years. That is to me a remarkable figure. It seems to be totally at variance with all the statistics I have been able to study and with the limited experience I have had. I don't refer to one-year cases, but those observed for over three years. If you will permit me, I would like to show the two slides. These are simply valuable as a basis of comparison with our own work, because it is, after all, only by an analysis of the statistics of the various large clinics that we, the individual workers, can really check up the value of our own figures. Carcinomata of the breast,—recurrences in the first year: in the non-radiated cases 28 per cent recurred at the end of the first year; with single small doses, 38 per cent; with several small doses, 37 per cent, and with intensive radiation 47 per cent of the cases had recurrence in the first year. The three different clinics show similar results: Carcinoma of the breast, 5-year study. In the first group are early operable cases with no glands, and in the second group are tumors with infiltration and glands. Let us study the early cases. Fourteen cases were radiated, with a recurrence of 78 per cent at end of five years. Of the 17 of these cases which were operated on, there was recurrence in but one case. Of Group 2 there were 83 per cent recurrences after radiation and only 69 per cent after operation without radiation. I appreciate the pitfalls of any statistics. Fifteen or twenty or even a hundred cases are not enough to establish the value of a method or treatment as complicated as this. Three hundred cases would give more reliable data, particularly if these were from one surgical clinic, with a definite surgical and radiotherapeutic technic. Such a record would be instructive. The results obtained so far do not mean that the radiation treatment is of absolutely no value, but they indicate that the problem demands a close study and a modification of our technic if the results are to be improved.

DR. LEE (closing): I have just one further word. First, I want to thank the others for their interesting papers. The particular

question which arises is: What is to be done for the primary inoperable carcinoma of the breast? Dr. Bowing's very excellent paper showed cases in which radical amputation had been done. I do not think cases of primary inoperable carcinoma of the breast ought to have radical amputation. I want to go on record on this point, and my reasons for it are these: I believe that in the presence of disseminated disease, you are not helping the patient by opening up new paths for further dissemination. Only when one can go wide of all disease does surgery seem logical. In our 54 cases, all operations were merely palliative removals, when a large ulcerating breast was becoming infected. One further point: of these 54 cases, ten are alive and four to-day have no evidence of disease, which I think is significant if you are considering the type of case you are dealing with. One further plea to this audience—let us bring more and more to these meetings, data upon cases treated over a considerable period of years.

Dr. Bowing (closing): There are two points I would like to leave for your consideration:

1.—The value of the fractional dose method. Dr. Schmitz has directed our attention to many of its important features. It has been my practice at the Mayo Clinic to employ the fractional dose over a certain and rather definite period. The amount of radium in the majority of cases varies from one to four 50-milligram tubes and the duration of application from a few hours to twenty-four hours, while the treatment session will never exceed three to four weeks, or at least the majority of the treatment will be applied in that time. This will reduce to a minimum the severity and duration of the radiation sickness. Should alarming symptoms occur at any time, the treatment may be omitted and a rest period allowed. Generally speaking, following an interval of two to four months, marked palliation will have occurred in the borderline and inoperable group and in some the initial result is astonishingly good. Time alone will tell how long this improvement will endure. At the next or subsequent visit should activity be found in the area or parts treated, I am confident that very little can be accomplished by another course of treatment although by cautious applications many of the impending or inevitable complications may be stopped or at least delayed. The results with the fractional or broken dose method are superior in our hands when compared with the intensive, single dose method.

2.—It is difficult to define this point, and if it were better understood, I am confident that it would lead to more efficient and rational treatment. We have all been impressed with certain cases under treatment in which the immediate response was prompt and required very little treatment as compared to the cases in which the immediate response was slow and required a much greater amount of treatment. This difference may be designated as the tendency to malignancy. In the first instance, it was very slight and easily overcome, while in the second instance it was firmly fixed and very difficult to overcome.

The fractional dose is of distinct value since it permits the treatment to be pushed to the limit, or it may be discontinued or modified at will, thus providing flexible and strictly individual treatment. Today, the determination of this factor seems impossible, but to a Wassermann or a Von Pirquet it may seem a simple problem. It would be of first importance in determining the most effective therapeutic formula. Professor Slye has definitely shown that in the laboratory animal this feature of malignancy is an inheritable factor. In short, it obeys the law of Mendel; it can be numerically predicted and verified.

Dr. Stevens (closing): In answer to Dr. Ullmann's question, by "universal tension," I mean voltages up to 140,000. As to Dr. Hirsch, I think perhaps that he has taken me wrongly. My high percentage of 72 was obtained in the entire group. If one throws out the hopeless cases that were

included, then the percentage rises by about 10 per cent. That is quite different, as compared with the figures of the very best surgeons of older days, who figured upon getting well only 50 per cent of the absolutely localized cases. As already stated in my paper, most of the cases were irradiated as a routine following surgery, and I feel sure that the promptness with which radiation therapy was begun had a great deal to do with the results.

Discussion of paper by Dr. P. M. Hickey, "Instruction of Undergraduates in Roentgenology," published in RADIOLOGY, Feb., 1924, p. 62.

DR. R. G. ALLISON (Minneapolis): Dr. Hickey and I have discussed this matter of medical education in roentgenology informally, and I think we are quite agreed on most of the topics. Unfortunately we do not always have the teaching facilities that Dr. Hickey has in Michigan, and the curriculum is very much crowded. In some of the schools in Minnesota we have only twelve hours, and the two sections of the senior class are given twelve lectures each. That means that all the instruction in roentgenology that the students are required to take is a lecture course of twelve hours during their senior year. Of course, it is quite futile to attempt to give a comprehensive course in roentgenology in twelve hours. What I have attempted to do is to devote the first lecture period to a practical demonstration of the apparatus used in roentgenology. I take the men into the fluoroscopic room and show them an X-ray machine, the fluoroscope, a tube and intensifying screens, and especially tell them where intensifying screens should be used. In other words, I try to at least let them see all the apparatus we use in the practice of roentgenology. The remaining lectures are devoted practically entirely to X-ray pathology. I attempt to tell them the value and limitations of the X-ray in the diagnosis of conditions occurring in this particular area. I try to show them at least one lantern slide of a typical class of everything covered in that particular area. I manage, by cramming, to get these subjects into the eleven lectures which form the quota. As regards elective courses, I have felt that most of the men that will do their own X-ray work are the men who will be in the rural communities, and I have arranged my elective courses so that they are purely on X-ray interpretation. Quite a number of the men elect the course each year, more than I can accommodate, from the class, and they get two hours a day through the entire quarter, six days a week, that are devoted entirely to fluoroscopic and plate interpretation. I realize the necessity for teaching the men technic, but I have felt that the really valuable thing for them to get is their interpretation. When they get out and purchase an X-ray machine of their own, the commercial men can at least teach them the technic necessary,—if they do not teach the technic as well as I do, I feel that I can teach the pathology a bit better. So in the very limited time we have for the course, I feel that it is better to give them as much interpretation as we possibly can, even though we have to sacrifice the giving of the technic.

DR. R. R. NEWELL (San Francisco): I have been waiting very anxiously to hear what Dr. Hickey would say about instruction in roentgenology, for it has been a very real problem with us in San Francisco. Dr. Chamberlain has only 33 hours of required work. Of this, 22 hours are devoted to sections in which we divide the class up into about five students to a section and actually lead them over the X-ray plates and X-ray physics and X-ray technic. I was very much interested in what Dr. Allison said about the division of his course. We have thought that it is essential to give the students a good deal of the physics of the X-ray. We have thought that it is worth while to spend several hours in teaching them that X-rays do travel in straight lines, that what they are looking at are shadows, not pictures, and teaching them to understand why fat does not cast so dense a shadow as the liver (in one case they are

looking at the shadow of carbon with an atomic weight of 12, and in the other case, oxygen, in water, with an atomic weight of 16); and make them understand the tremendous discrepancy in X-ray density of only slight differences in atomic weight. Dr. Hickey remarked the avidity of the students for instruction in X-ray, and we have been happily astonished in the same manner. We have offered several optional courses and have found the students fairly scrambling for a chance to get the instruction, both in the fluoroscopic room, in which, of course, the sections are necessarily limited, and also for plate interpretation and the general X-ray diagnostic course, which is also divided into sections.

DR. LEON T. LEWALD (New York): I would like to ask Dr. Hickey a question: the Association of American Colleges has put in a certain number of hours as required for Class A medical colleges. I think it is variously interpreted. Dr. Alfred Gray, who introduced the measure, stated it was thirty-six hours as a minimum requirement, but I do not know whether even that is held to be obligatory or not with all the medical schools of Class A. I wish Dr. Hickey would enlighten us about that, because we are about to revise our course at the New York University, and the consensus of opinion seems to be that all the subjects are being given an undue number of hours, and there is a tendency to cut down rather than increase instruction in various branches, and the question has come up as to what the course in roentgenology should be.

DR. L. J. MENVILLE: In the Medical Department of Tulane University, we begin the instruction in radiology with the second-year class in physical diagnosis. Dr. Bel, Professor of Theory and Practice, instructs the students in this manner: "What are the most essential methods of physical diagnosis employed?" Inspection, palpation, percussion, auscultation, and X-ray, and he considers the X-ray as valuable—perhaps more valuable—than any other single method of physical diagnosis. We give the students in the second year didactic lectures and take up about four hours a week over at the Presbyterian Hospital, demonstrating the normal. We have these students in physical diagnosis, after they have become fairly efficient in percussion, come into the fluoroscopic room, and have them do their percussion, outline the heart with a skin pencil, and put ordinary fuse wire around the marking and subject the patient or student to a fluoroscopic examination to determine how correct their percussion was, etc. At the end of the second year we have X-ray questions in physical diagnosis. These men must pass that X-ray examination in order to complete their work in physical diagnosis. We have, every Monday, a pathological conference composed of a competent pathologist, internist, and radiologist, and the student body, of course, is required to be in attendance. In the senior year they have one lecture a week on radiology.

I was very much interested in Dr. Hickey's paper, because we all know his prominence in roentgenology. I wish to make a prophecy that it will not be very long before every medical college in the United States will become very much interested in roentgenology, to the point that instruction will be given. In my paper before this body[1] I showed where 65 per cent of the State Boards of Medical Examiners throughout the United States said that they considered the science of roentgenology of sufficient importance so that the medical boards of this country should give more consideration to it. The medical schools will be forced to recognize roentgenology more seriously, whether they want to or not, by the various state boards asking X-ray questions in their examinations.

[1]See page 183, this issue.

PRACTICAL ASPECTS OF X-RAY MEASUREMENT, WITH SPECIAL REFERENCE TO A STANDARD UNIT OF DOSAGE[1]

By H. N. BEETS, B.S., and ROBERT A. ARENS, M.D.
Physicist and Roentgenologist, Respectively, Michael Reese Hospital, Chicago, Illinois

IN studying the problem of X-ray dosage we must consider both the quality of the ray transmitted by the filter, and the quantity transmitted per unit of time. Both the quality and quantity of this transmitted ray should be expressed in fundamental terms, if possible. Quality at present is expressed in terms of penetration or wave length, the latter a property of the ray itself, an objective standard. Quantity, on the other hand, is generally expressed biologically in terms of erythema, a phenomenon which involves two variable factors, namely, the patient's reaction and the roentgenologist's interpretation of that reaction. We should seek a unit of quantity which is fundamental, determined by a property of the rays themselves, and measurable to an exact degree; to bring into accord the various ideas of roentgenologists as to the quality or quantity, or both, to be used in X-ray therapy. Such a unit has already been presented and will hereinafter be described.

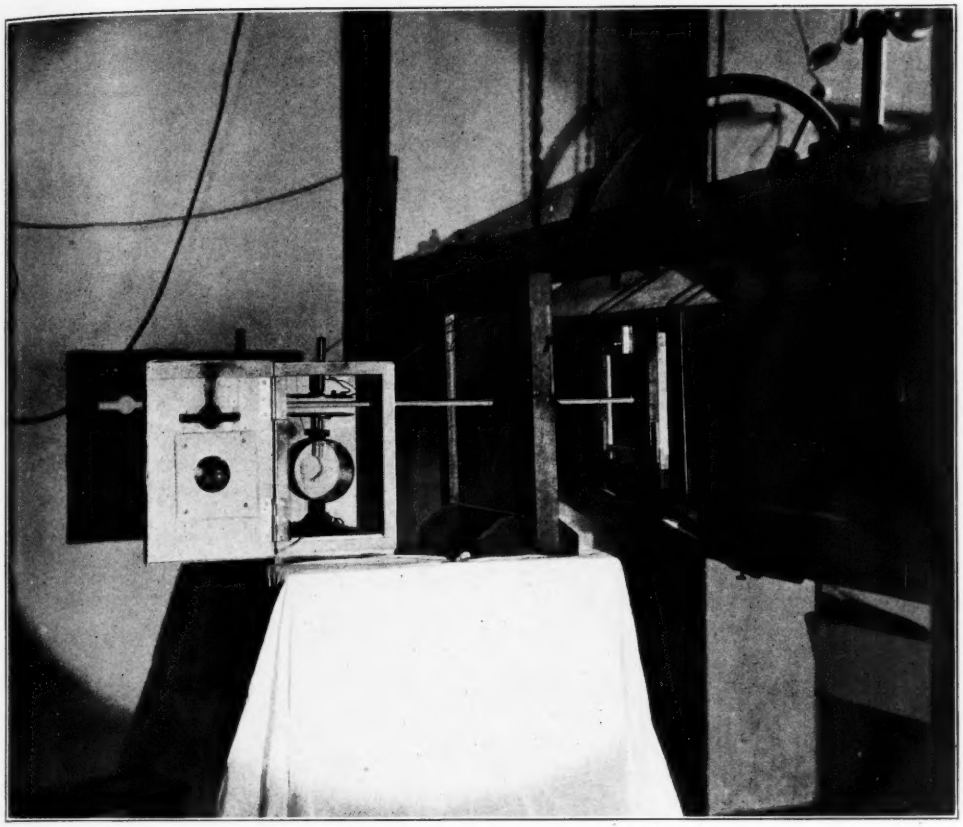
Physics was not a science until physicists agreed on certain definite units of length, mass, and time; chemistry was not a science until chemists began to talk in terms of atomic and molecular weights, grams, cubic centimeters, and other definite units; units which mean the same thing to all chemists and to all physicists. The physician in writing out a prescription states so many minims, drams, grams, or ounces of a drug, or so many c.c. of a solution of a definite concentration. Not that any two physicians will necessarily prescribe the same amounts or the same drugs, but the drug and the amount are both in definite terms which allow of only one interpretation.

What, then, is the condition in the X-ray field? One roentgenologist states that he uses so many milliampere minutes, at so many kilovolts, using a certain filter, and skin target distance to obtain a so-called erythema dose. But like numbers of milliampere minutes do not mean the same amount of X-ray energy with different machines, no two men agreeing on what constitutes an erythema dose. In general, equal amounts of filtered radiation will not produce a similar erythematous reaction on different patients, so that to define the amount of X-rays used, entirely by its biological effect, is very unsatisfactory.

When you order an electric light bulb you are not primarily interested in the number of watts of power consumed in that bulb, but in the candle power coming from it. The old carbon filament and the newer Mazda may consume the same number of watts, but there is no doubt about which one gives the most light. Similarly, in X-rays we should not rate our tubes and apparatus by input, but by output and in terms of an X-ray candle power. As in the visible light, we cannot say that a red light is three times as strong as a blue one, but can only speak of relative intensities for two lights of the same color, so in X-rays we must first state the quality of the ray and then we can compare quantities. Our aim in X-ray therapy should be to have some unit of quantity for a given quality of ray, and then to prescribe multiples or fractions of this quantity. This would place X-ray therapy on a scientific basis whereby one roentgenologist could exactly interpret another's technic, and intelligently compare biological results.

The iontoquantimeter and the intensimeter are at the present time perhaps the most widely used instruments for measuring quality and quantity. They are good for making quality measurements, because for this we need only the ratio of surface and depth intensities but not their absolute values. But for quantity, relative measurements are not of much value unless we

[1]Read before the Radiological Society of North America at Rochester, Minnesota, December 3-7, 1923.



The Apparatus

know what they are relative to. If by carefully working toward it, the "erythema" time of one machine is known, the "erythema" time of another machine can be determined by measuring the output of each with the same instrument. This at best is tedious. What we want is a unit that can be evaluated in terms of well-established units, and duplicated at will.

X-rays are best measured by their ionizing effect on gases. Therefore, if possible, our unit should be defined in terms of ionization. Friedrich and Kroenig have given us the best solution up to the present time. They have advocated an ionization unit based on well-known physical units and called it the X-ray Einheit, or the "e" unit. They have defined the "e" unit as that quantity of X-rays which by the ionization produced in one cubic centimeter of air traversed by the X-rays, permits one electrostatic unit of quantity of electricity to be transported across an electrical field under saturation conditions, that is, the "e" unit may be considered as describing either the quantity of electricity transported, or the quantity of rays which produces this quantity of electricity. The "e" unit is, therefore, an electrical unit of current and can be measured by instruments which measure small currents, viz., the galvanometer, the electrometer, or the electroscope. If the electroscope is used, the units involved in its determination are such well-known units as the ampere, the volt, and the farad, all of them very definite concepts having the same meaning all over the world. The medium is air, the composition of which is

practically the same in all places, the only variation being in the density of the air with changes in barometric pressure.

We began working with this "e" unit at the Michael Reese Hospital nearly eighteen

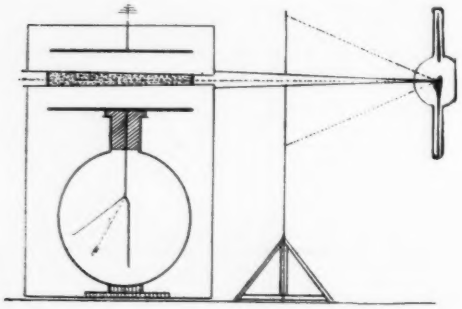


Fig. 1

months ago, using for its determination an exact duplicate of the apparatus described by Friedrich and Kroenig. This apparatus is extremely delicate, and quite complicated, technically fairly satisfactory but not at all satisfactory for use under the conditions of routine practice. The problem then was to devise an instrument that was simple, rugged, and at the same time reliable and giving a high degree of accuracy; an apparatus that would enable us to determine quality in the customary units, and quantity in terms of the "e" unit. It had to be simple to operate, rugged to insure its not getting out of order easily, and compact, because space was a consideration. These requirements ruled out at once the galvanometer and electrometer, leaving only the electroscope.

Figure 1 shows what is, perhaps, the simplest combination of an ionization chamber and electroscope. The chamber consists of two circular parallel conducting plates, one directly connected to the electroscope without the use of a cable, the other grounded. The filtered X-ray beam in passing between these plates traverses no substance other than air. The electroscope and the two parallel plates are placed in a lead-covered box to protect the system from undesirable exposure and from electrostatic disturbances. A separate screen is placed between the box and the tube. This screen has four uses:

1. It protects the box and operator from unwanted radiation.
2. An aperture in this screen in line with the aperture in the box helps to define the beam passing between the two plates, making its cross-section very sharp and more nearly cylindrical.
3. A slot beneath the aperture makes a very convenient holder for test filters, i.e., the filter can be changed without stopping the tube, and it also is the holder for the filters used in the Duane wave-length measurement.
4. On the other side of the screen is a lead drop that can be raised or lowered over the aperture by means of a cord, thus permitting the determination of the natural leak of the instrument with the tube running.

This leak is so small as to be readable only after a period of many minutes, thus eliminating the necessity of a correction on this account. This screen is lowered between readings to protect the electroscope while it is being charged, and raised when the observer is ready to take another reading.

A beam of light passing through the box at right angles to the direction of the X-ray beam projects the image of the electroscope leaf and scale, through an adjustable lens, at any distance on a screen or wall. This makes it possible to read the time of fall of the leaf without exposing the operator to the radiation coming from the tube. The electroscope can be charged by means of a hard rubber rod through an aperture on the side away from the tube, or, better still, by a small charging device consisting of a small step-up transformer, a condenser, and a kenotron so arranged that by pushing a button the electroscope can be charged. (Those who have tried to charge

an iontoquantimeter by the usual static charger will appreciate this arrangement.)

The theory of our measuring apparatus is very simple. Between the plates we have an electric field which draws the ions produced by the ray to the plates, this constituting the ionization current, i.e., the transportation of electricity mentioned in the definition of the "e" unit. The electrical capacity of any system is defined as the ratio of the quantity of electricity on that system to its potential. Increasing the quantity of electricity will increase the potential of the system, but not its capacity. Algebraically,

$$q_1 = C\ V_1 \qquad (1)$$

$$q_2 = C\ V_2 \qquad (2)$$

Subtracting the one from the other we have

$$Q = q_1 - q_2 = C\ (V_1 - V_2) \qquad (3).$$

The divergence of the leaf of any electroscope is a measure of the potential or voltage on that electroscope. Suppose we take two positions of this leaf and determine the voltage in each case by means of an electrostatic voltmeter, then the difference of the two readings will give us the term $(V_1 - V_2)$. The capacity of the electroscope for this range is easily measured by the ordinary methods of capacity measurement. When the leaf falls from the first position to the second[2] under the influence of the X-rays, a certain quantity of electricity Q is transported from the electroscope to the ground. This is the Q concerned in the definition of "e."

If it requires t seconds for the leaf to fall between the two positions, and the volume of air traversed by the X-ray beam is w cubic centimeters, then the "e" per unit of time is given by the equation

$$\text{"e"/sec} = \frac{C\ (V_1 - V_2)}{w \times t \times 300} \qquad (4),$$

300 being the factor required to change volts to electrostatic units. We have found it convenient to express our tube output in "e" per hour, namely,

$$\text{"e"/hour} = \frac{C\ (V_1 - V_2)\ 3600}{w \times t \times 300} \qquad (5).$$

Since C, $(V_1 - V_2)$, w, 3600 (sec. per hour), 300, are constants, the equation reduces to

$$\text{"e" per hour} = \frac{\text{CONSTANT}}{t}.$$

If the constant is once determined, a table can be made showing in one column the number of seconds required to discharge the electroscope between the two points, in

DISCHARGE TIME SECONDS	E / hour
9	1400
10	1250
11	1150
12	1050
13	950
⋮	⋮
25	500
26	500
⋮	⋮

Fig. 2

the other the rate of delivery of "e" units per hour, as in Figure 2. That is, the only measurement that need be made by the observer is the time of fall of the leaf between these two predetermined positions. It will be noted that this gives us a measure of the radiation coming from the tube transmitted by the filter, and from nowhere else. It is the quantity we are primarily interested in because it can be duplicated; it is therefore

[2] The potential gradient between the plates is sufficient to ensure the saturation value of the ionization current for this range.

the quantity that we record on the history sheet.

While our main interest is in this radiation, this being determined by the use of our simple instrument, measuring in air

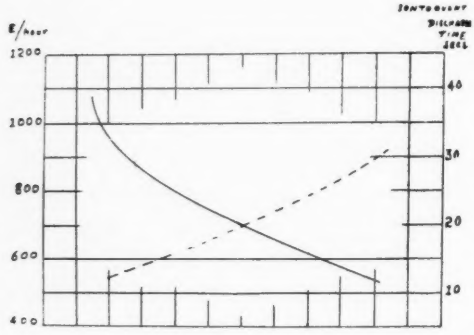


Fig. 3

(not over a patient or phantom), we have found that an iontoquantimeter attachment is a very useful accessory while a patient is being treated. An insulated cable and cylindrical chamber of the iontoquantimeter type fits into the side of the box, making electrical contact with the lower plate of the ionization chamber. During treatment this iontoquantimeter attachment can be placed at will on the patient and periodic readings made of the tube output, if so desired.

The addition of the cable does not change the voltage drop between the two positions of the electroscope leaf, but does change the capacity of the instrument and the volume of air ionized. We, therefore, use it for relative measurements only. If the chamber is placed on the patient, it will read not only the radiation coming from the tube, but also that scattered back by the patient. By making two separate readings, the first in air, the second on the patient at the same target distance, we can determine the amount scattered back. Since the iontoquantimeter readings are only relative we relate them to the absolute readings, as determined by the electroscope alone, by the two curves, shown in Figure 3. The continuous line represents the "e" per hour delivered, as measured by the electroscope for various conditions; the dotted line the iontoquantimeter readings in seconds under these same conditions. To obtain the "e" reading from the iontoquantimeter time, we drop from the dotted line along the ordinate to the continuous curve and then follow through to the left to the "e" axis. This makes it necessary for the operator to read only the time of discharge from the projected image of the leaf. If readings are taken every five or ten minutes over the hour, they can be averaged and then, by referring to the curve or a table similar to that in Figure 2, read the number of "e" units delivered to the patient's skin.

As stated, in X-ray therapy the important considerations are quantity and quality. The quantity measurements have been discussed. The same apparatus without modification is used to measure quality. Quality in terms of per cent depth dose can be determined by using the iontoquantimeter attachment and proceeding in the usual way, i.e., measuring the discharge time of the iontoquantimeter when the small chamber is at the surface, and also the time when the chamber is 10 cm. beneath the surface of a phantom. The depth dose is then the ratio of the surface time to the depth time. Quality in terms of effective wave length can be measured by the Duane method, either with or without the iontoquantimeter attachment, by noting the fraction of the energy coming through the filter that will pass through a second filter of 1 mm. copper or 4 mm. aluminum.[3] The slot in the screen, between the electroscope and tube, will hold this second filter very easily and it can be placed or removed without stopping the tube.

There are a few sources of error to be considered in the measurement of output in "e" units with this apparatus. There is no perceptible natural leak even though the tube be running, and therefore no correction to be made for it. Dielectric errors are eliminated by eliminating the dielectric. The factors involved in equation (5) are

[3]Duane, Am. Jour. of Roentgenol., March, 1922, p. 170.

time, volume, potential, and capacity. All errors involved in measuring any of these will appear in the result. The time of discharge is kept within 10 to 30 seconds, sufficiently large so that an error in the stop-watch readings will introduce only a small error into the end-result, while the time is not so great as to make readings inconvenient. The greatest error occurs in measuring the effective volume of the air traversed by the X-ray beam between the plates of the instrument. The diameter of the beam is measured at its two ends by placing two dental films vertical to the beam. This diameter is about 1.0 cm. and can be easily measured to 0.20 mm., or to within about 2 per cent. The length of the plates is over 10 cm. and can be measured with an error of less than 1 per cent, but there is an edge effect (Fig. 4) which makes this the least accurate dimension. This error might be eliminated entirely by the use of a guard ring, but the guard ring would complicate the apparatus considerably. If one instrument were equipped with this guard ring, the edge effect could be accurately measured and an allowance made for it in all similar instruments. We have reduced this error to a minimum by the simple expedient of placing the plates near to the walls of the box.

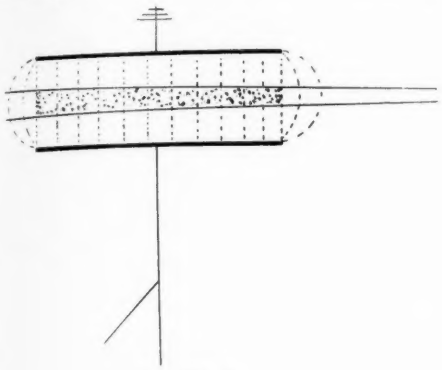


Fig. 4

The potential drop (V_1—V_2) can be measured by an electrostatic voltmeter with an error not exceeding 2 per cent. The capacity can also be measured to the same degree of accuracy in a reasonable period of time by comparison with a standard capacity. The error in the calculation of the volume is a constant error and can be corrected for. Time, potential, and capacity introduce the variable errors which cannot be corrected for. With reasonable care the total error should not exceed 5 per cent, which, in our judgment, is a satisfactory degree of accuracy for therapeutic dosage. By covering all the openings in the box with a thin sheet of celluloid, and using a drying agent such as $CaCl_2$, the moisture content of the box containing the electroscope may be kept relatively constant and errors due to changes in the humidity avoided. A correction will also have to be made for appreciable differences in air density. This can be calculated.

In our early experience we made some mistakes that it will perhaps be well to call attention to. First, we assumed the beam between the plates to be cylindrical; second, we neglected the edge effect, thereby using in our calculations too small a volume and therefore too many apparent "e" per hour. Of this apparent "e," we used from 1700 to as high as 2100 "e" delivered to the patient's skin. The volume correction has been made in our later work and we are now using the corrected number of "e," making our dosage range from 1500 to 1700 "e."

In conclusion, the electrostatic, or "e" unit, is a logical, practical, and desirable unit. Logical, because it is an absolute unit based on fundamental properties of the X-ray itself; practical, that is, suitable for every-day routine because its measurement can be easily, quickly, and accurately made by using an apparatus similar to the one described; desirable, because it will enable roentgenologists to *know* exactly the dosage being applied and to compare it with that given by others.

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DISCUSSION

DR. ROBERT A. ARENS (Chicago): I am glad that Dr. Schmitz, while apparently arguing to the contrary, agrees with us in our work. If he will investigate the electroscope as laid down by Mr. Beets and will observe the work that has been done with it, he will find that we have done exactly what he asks for, within a reasonable degree of accuracy. It is possible to do just this: to correlate every man's technic. I do not believe you will ever see two or more manufacturers get their machines so standardized, or agree as to the methods of putting these machines together to such a point as to insure 100 per cent conformity, especially in comparison with other men. Here recently, in order to get some idea of conditions, we wrote to six manufacturers asking each to send us quarter, half, three-quarters, and one millimeter copper filters of a certain size. It was just a little bit surprising when we came to measure up some of these filters, especially the half-millimeter size, to find that they varied from thirty-five to fifty-seven hundredths of a millimeter. Let us take it for granted that your outfits are standardized and let the manufacturer tell you what your tube is delivering—what about your filters? The electroscope, as designed by Mr. Beets, will do this. We have eliminated all our sources of error to within a practical degree on the apparatus. We do not care particularly about your voltage; we do not care about the milliamperage; we do not care especially about the skin target distance or the thickness of the filter. I can lay out a treatment for a patient by stating, "Give this patient so many eltectrostatic units with a certain wave length," and that treatment can be given without any difficulty. Why? Because the electroscope, as designed, as operated, will measure the quantity delivered, at a distance in air corresponding to the patient's skin. We make no allowance for secondary radiation, because that is a common factor in all patients. Whether it occurs more or less in two individuals is not of special interest. What we are interested in is a measurable factor that can be duplicated. The "e" unit is measured in air, which is the same medium we can all use for measuring in on every machine, thereby correlating every roentgenologist's technic. It was only last night that I was talking with two fellow members, and one asked me, "What is your erythema time or what is the time at which you are treating under a certain condition?" I replied on a basis of units. The other man asked me the same question; then we tried to compare technic, and tried to compare how much we were giving for our so-called "erythema dose." It was absolutely impossible to get together. One man had his type of equipment, another man had another, and we had a third. Now apparently the particular equipment we are using is a little slower than theirs. Suppose we had used the same technic they had used, or vice versa? In one case the patient would be under-exposed; in the other, over-exposed. And take, for illustration, a repair made to our equipment. Certain parts had become dirty, with consequent corrosion, followed by leakage, and it was necessary to have new parts replace the old ones. The equipment when again restored to usefulness was 20 per cent faster than it had been before; in other words, it delivered under the same conditions as we observed before, as far as our settings were concerned, 20 per cent more X-ray in the same length of time. Supposing that we had taken for granted that our machine was the same, and let us say that we had delivered the skin toleration dose according to our previous technic; it is certain that it would have been necessary for my insurance company to have raised my rate the next year. We do not offer a 100 per cent article. We admit that there is a possibility of error, but we believe that we have held it

down to a practical degree. The apparatus will accurately measure to within 5 per cent. I believe that it is infinitely more accurate than the comparison of any two "erythema doses." I doubt whether you will find half a dozen men in this room who will agree as to what constitutes an "erythema dose."

Radiotherapy of the ear.—The author reports two cases of bilateral deafness due to ankylosis of the ossicles and a case of Ménière's labyrinthine vertigo, all of which were treated to radiotherapy. In the labyrinth case a total of 10 units H were given within five days, the normal ray being directed toward the middle ear, the ossicles and labyrinthic vestibule. A second and third series of séances were given at intervals of about a month. The paroxysmal and vertiginous conditions have been greatly ameliorated but audition was not improved.

The other two cases show that radiotherapy can restore a certain mobility to the small articulations of the ear. Although in these two cases the ankylosis was old and advanced both patients recovered part of their audition. Probably the results would be more satisfactory still in less advanced lesions. The treatment should be in collaboration with the aurist, who should make a pneumatic mobilization of the chain of ossicles simultaneously. — *Radiotherapy in Chronic Diseases of the Middle and Internal Ear (Quelques essais de radiothérapie dans les affections chroniques de l'oreille moyenne et de l'oreille interne). A. Raynal. Jour. de Radiol. et d'Electrol., 1923, VII, 180.*

Diaphragmatic hernia.—In the two cases related the patients came to the author with a previous X-ray diagnosis of traumatic diaphragmatic hernia of the stomach. In the first case radioscopic examination of the patient in various positions showed the stomach to be always sub-diaphragmatic, but in a subsequent exploration the bismuth meal was seen to arrive at the splenic angle and then to continue its progress in the thorax almost to the anterior arch of the second rib, then descend vertically, clearing the diaphragm and continuing thence to make a normal progression. The case instead of being a gastric diaphragmatic hernia was a colic diaphragmatic hernia. The prior diagnosis was probably based on the presence of a clear supra-diaphragmatic bulb due to the presence of the herniated colon distended with gas at the time of examination and which was mistaken for the stomach. The true condition was made evident by a bismuth lavage.

The second case was almost similar to the first but in this instance a radiograph showed the colic hernia strangulated in the diaphragmatic opening. An opaque lavage in this case not only permitted an exact and complete diagnosis of the real condition but showed the urgent necessity for an operation.

The conclusion to be drawn from these two cases is that in the presence of a diaphragmatic hernia of the stomach it is always necessary to think of the possible hernia of the intestine and to seek it. Of all the viscera susceptible of constituting the contents of a hernia the intestine appears to be the most indicated, its form, contents and motility predisposing to it. And in fact it is the intestine which almost always first presents to the natural orifices of the abdominal wall. It is, therefore, but logical to think that it ought to be precipitated into any breech at any part of the walls of the intestine. If among organs herniated through the diaphragm, statistics show a proportion in favor of the stomach, it may be asked if incomplete examinations not operatively controlled have not been responsible for many gastro-intestinal or simply intestinal hernias being classed as hernias of the stomach.

In both the author's cases the corrected diagnosis was verified by operation.—*Two Cases of Traumatic Diaphragmatic Hernia (A propos de deux cas de hernie diaphragmatique traumatique). J. Garcin. Jour. de Radiol. et d'Electrol., 1923, VII, 177.*

EDITORIAL

THE MID-ANNUAL MEETING

The mid-annual meeting of the Radiological Society of North America is to be held at the Sherman Hotel, Chicago, on June 6 and 7 next.

Judging from the interest being manifested by the membership at large, this meeting should be the best attended in the history of the society. And, it is believed that the program being arranged will fully justify a large attendance.

The program is rapidly nearing completion and it is hoped that a preliminary announcement may be published in the April number of *Radiology*. Any member desiring to present a paper at this meeting should confer at once with some member of the Program Committee or the president of the society. Dr. A. W. Crane, Kalamazoo, Michigan, is chairman of the Program Committee.

Present indications are that the program will contain papers of especial importance and value in diagnosis and therapy. In therapy we have been promised some very important contributions containing results of some recent important research in physics and biology.

There will be presented an important scientific exhibit and all members are urgently requested to contribute to this. This exhibit can be made of great educational value not only to radiologists but to physicians in every branch of medicine, a large number of whom will be in Chicago for the A. M. A. meeting. Many of them will come a day or two in advance of that meeting for the purpose of attending the meeting of our society.

Dr. I. S. Trostler, 25 E. Washington Street, Chicago, has charge of these exhibits. Let us all help to make it one of which we, as radiologists, may well be proud.

A convenient and effective way in which to present an exhibit is to make five by seven reductions of plates of important cases. These should be framed in black paper and labeled with a diagnosis and brief history of the case.

If the members of the society will carefully study the program before the meeting, prepare lantern slides and bring with them histories of cases applicable to the papers which they aim to discuss, the value of the meeting will be enhanced. Now is the time to begin preparing material for this meeting.

It has been suggested, and seems to meet with the approval of a large number of our members, that those who present papers should condense them for reading, presenting the full text to the secretary for publication in this journal later on. Much valuable time would thus be saved for discussion. It is hoped, however, that no one will allow this suggestion to prevent him from reading the full text of a valuable paper if the author desires to present it in that way. The suggestion only is that it might be advantageous in some instances for authors to make practical application of this suggestion. Nothing of value would be lost to the society and much should be gained in time. The time allowed at this meeting for the reading of papers by members has been limited to twenty minutes; for guests, thirty minutes. Let us make it snappy this year by having the usual number of papers but more time for discussions. Your president bespeaks the co-operation of authors in this matter for the benefit of all concerned.

The scientific sessions of the Chicago meeting will be thrown open to all interested persons who register, whether or not

they are members of the society. These meetings are equivalent to a post-graduate course in radiology. No physician is too old or too young or too well-informed not to be benefited by such a program.

The scientific section will be of undoubted value and interest to every physician regardless of what branch of medicine he may be specializing in. In these days X-Ray diagnosis is a most important factor in every department of medicine and X-Ray and Radium Therapy are being considered more and more in the treatment of disease. Therefore, the physician who desires to keep abreast of the times should keep informed on the advancement of radiology.

The Radiological Society of North America extends a most cordial invitation to all physicians to attend its sessions in Chicago and to share in the benefits which the program will offer. The young man who is just entering the field of radiology and earnestly striving to do efficient work is especially welcome, and the meeting should be of particular value to him. Among the young men of today are the big, authoritative men of the future, the men who will guide the destinies of radiological science when the men at the helm today give way. It is, therefore, most important that the young men become affiliated with the society at as early a date as possible. The officers of the society are eager to meet these young men and it is hoped that they will make themselves known at the meeting. It is to our mutual advantage to become acquainted. Learn to pull together in this great work of which there is plenty for willing hands to do.

Remember the dates, June 6 and 7, 1924, Hotel Sherman, Chicago.

ADDRESS BY WILLIAM J. MAYO, M.D., BEFORE THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

ROCHESTER, MINNESOTA, DECEMBER 3-7, 1923

Mr. President, Ladies and Gentlemen: First, I wish to express the sentiment of the entire Clinic by saying that we are all very glad to have the Radiological Society meet with us here in Rochester. We are particularly glad because you bring those things that are fresh; you talk these things over before us and they interest all of us and especially those of us who are particularly interested in the things in which you are interested. They are the ones who will absorb those things that you show them today and bring them to the rest of us through the patients to-morrow and thereafter. We are all proud of the radiological staff here and I think we have reason to be. I look around and see Dr. Carman, who has done so much for the radiology of the gastro-intestinal tract; Dr. Moore, Dr. Sutherland, Dr. Miller, Dr. Desjardins and Dr. Bowing. These are the men who are working with us every day and who are telling us what to do and why. Dr. Carman speaks of the few times when we are able, perhaps, to catch him in a mistake. He has us on the hip all the time. (Applause and laughter.)

I regret very much that my brother is not here. You miss him and he misses you. I really am only taking his place. We used to have here in Rochester a Colonel G., who had been a great soldier in the Civil War. When he came back he used to talk to us on every possible occasion and on every possible subject. He spoke so much that he spoke well. (Laughter.) Once when he went away his son was put on to fill his place on a public occasion. Our newspapers speaking of the affair said that Colonel G. had been called out of town, but that his son had taken his place; that he got up and assumed the well-known attitude of his father, with one hand in the lapel of his coat and the other under his coat tail; but that when he opened his mouth the audience was painfully aware that "Pa was out in South Dakota." (Laughter.)

On an occasion of this kind, when we should all be merry, it is really too bad for me to talk a little shop, especially when I see all the ladies are present here to-night. Incidentally I want to congratulate the members of this Society that their wives are with them. And I want also to congrat-

ulate the ladies that they are wise enough to be with you. (Applause and laughter.) My wife is here. She will tell me when I get home that I talked badly. (Laughter.) Our wives always tell us the truth.

There is not such a lot of joy comes into our lives. We are dealing with sick people all the time. But doctors really like merriment. I heard another Lincoln story the other day from a Canadian. It seems that while Lincoln was running for president he was up in Canada for a little rest, and *the Canard* got out that Abraham Lincoln was very mercenary. An old clergyman said to him, "Mr. Lincoln, is it true that you want to be president of the United States for the money there is in it? That you love money?" Lincoln replied, "I was born on a farm and our people were very poor. But next to us was a farm where the people were even poorer than we were. They had a boy about my age and when my mother would make gingerbread, which is as near as we got toward cake, she would always give me some to take over to the neighbor's boy. Once she made a real big gingerbread and gave me a big piece to take over to the neighbor's boy. I sat down and watched him eat his gingerbread. After he got through he licked the corners of his mouth and his fingers and said, 'Abe, I don't suppose there is a boy in this state who likes gingerbread better than I do, but I don't see much of it.' "

The work that you radiologists do is of greatest importance to the surgeon. You cannot think of a blind surgeon. You can think of the blind people succeeding in other lines, but not of a blind surgeon with a knife in his hand. A surgeon is dangerous enough when his eyes are open. Now it is because you have extended our sense of sight, and have made us see in dark places, that makes the surgeon full of gratitude, of great respectfulness to you. Much of what has been accomplished has come through the sense of sight. The sense of touch comes next in value. Our hearing is very misleading. We all know how defective and perverted our sense of taste is, and our sense of smell too often is a nuisance. How does it happen that so much progress has been made through the sense of sight? The first of the special primitive senses to develop was the sense of taste, that the primitive mouth might refuse those things that were not useful as food. Smell came next, that the primitive mouth might be moved toward those things that might be good for food. Then hearing developed, and it was placed in the middle of the head to warn of danger that threatened from behind or either side, as well as the front. And then came the blessed sense of sight, and with it the growth of that part of our brain with which we do our thinking, or at least attempt to do our thinking. And then there developed direct channels, pathways, means of communication between the sense of sight and the whole of the brain, the organ of thought. If you put before a mechanic a long treatise telling what a certain piece of machinery is supposed to do, he may not know very much about it; but put before him a picture of the machine, and at once through the sense of sight he grasps what it is and what it means. Going back in history to Aristotle, the physician of Alexander the Great, about 350 B. C., we find him the first to elaborate the analytical method of investigating facts, largely, as he said, by the sense of sight. No wonder his philosophy lasted more than fifteen hundred years, until the time of Bacon, who in the thirteenth century introduced the method of experiment, taking up those things known to exist and experimenting and reasoning from them toward the unknown.

Roger Bacon was far ahead of his time, but the first scientist to accomplish anything experimentally in your field was Crookes, for after all, it was Crookes who discovered the X-ray. He was not the one who exploited it. He was not the one who made it useful to us—that was done by Roentgen. But the fundamental discovery on which it was based was made by Crookes.

In 1828, the Scotch botanist, Brown, first extended our sense of sight beyond the ordinary things seen in the microscope to those

particles of matter which are too small to be actually seen by themselves, but which are sufficiently large to reflect rays of light. Working at about the same time the great physicist, Dalton, was developing the theory of atoms in the constitution of the molecule. What he described as the "dance of the molecules" was the same phenomenon that was already known as "the Brownian movement."

Then came Thomas Graham, who in 1861 related the colloids to the observations of Dalton and Brown. Colloids lie between those things which we can see with the eye, or the eye aided by the microscope; 1 to 250,000ths of an inch, one-tenth micron, and 1 to 25,000,000ths of an inch or one ten-thousandth micron. They cannot be seen, but they are large enough to scatter a ray of light, and we see the reflection by the aid of the ultra-microscope. Colloids are little affected by gravity. Below the colloids we can see by the aid of the X-ray, the molecule and the atom, which are smaller than a ray of light, but are larger than the X-ray, which is 100,000,000ths of an inch; the atom refracts the light from the X-ray. The atom is not affected by gravity and is in constant movement. And it is with the X-ray that the atom and its constituent electrons and protons have been experimentally analyzed. When we know more about that shortest of all electro-magnetic vibrations that we speak of as the gamma ray of radium, which has a wave length of only one-billionth of an inch, it may bring to our sense of sight, in a new manner, many things now far beyond our ken. We know colors are only electro-magnetic vibrations of different wave lengths. If you have ever played with the man who has three shells and a pea, you have gotten the idea that the hand is quicker than the eye. But the camera and the spectroscope are so speedy that they show up even the gamma rays, the most minute of all, and enable us to measure them.

Investigators who have gone before have given us much, but all is not yet done. Steinmetz, who so recently died, said that one teaspoonful of water contains enough atomic power to drive a battleship across the ocean and back. Rutherford and Ashton estimate that during the life of 1 mg. of radium enough power is given off to raise the largest battleship into the air and hold it there for some time—I have forgotten within a minute or two how long. Great discoveries are yet before us. It is the next step, and in each step that is made in which you gentlemen will lead us, because in your hands are the X-ray and radium, which give off those electro-magnetic vibrations that may enable us to analyze the granules of the electron and the proton itself.

ORGANIZED MEDICINE AND ITS RELATION TO ROENTGENOLOGY

If we consider that the science of roentgenology is indispensable to "organized medicine," we must first apply the acid test to this theory by attempting to visualize the present practice of medicine without the X-ray. Is there a modern physician who would agree to continue his profession without the valuable aid of the X-ray? I do not think there is.

Each year shows an improvement in our specialty, whether it be diagnostic or therapeutic, and each year increased recognition is given this valued branch of medicine.

But the fear has grown within me that possibly we are neglecting some phases of our work, and this fear has crystallized into the following questions:

1. Are the roentgenologists protected as other medical specialties are?
2. How important does the medical profession consider the science of roentgenology? Is it considered a science?
3. Has roentgenology a secure place in the medical world? What are its future prospects?

These questions I have carefully reviewed for some time and finally decided to have them answered by men prominent in "organized medicine."

As president of the Louisiana State Board of Medical Examiners, I sent out a questionnaire to the various executive officers of the State Boards of the United States, with the following questions:

1. Are there any X-ray questions in your examination?
2. Do you think that the science of roentgenology has attained sufficient importance in medicine so that the Medical Examining Boards should give more attention to it?
3. Do you permit other than regular licensed physicians to practice the science of roentgenology? If so, to whom is this practice granted?
4. Is the practice of roentgenology considered as practicing medicine in your state?

The reason for asking the first question was to find out whether the various State Boards thought the physicians taking the examination should have received X-ray training in their medical course.

The reason for the second question was to find out the attitude of the State Boards of Medical Examiners toward the science of roentgenology.

The reason for the third question was to ascertain if the roentgenologists were being protected by the various medical laws, in the same manner as other specialties of medicine; also to find out if technicians were permitted by law to have the same privileges as the regular licensed roentgenologists.

The reason for the fourth question was to try to pin down the opinion given in answer to Question No. 3, especially when the answer was somewhat evasive.

I have received answers from every state except four: New York, Illinois, Oklahoma and Oregon.

In answer to Question No. 1, 24 State Boards, or 52 per cent, answered that they did not incorporate X-ray questions in their examinations, and 14 State Boards, or 30 per cent, did incorporate X-ray questions in their examinations. Three states answered that they would ask X-ray questions at a later time.

In answer to Question No. 2, 30 State Boards, or 65 per cent, answered that they thought that the science of roentgenology had attained sufficient importance in medicine that Medical Examining Boards should give more attention to it. Eleven State Boards, or 24 per cent, did not consider it of sufficient importance to give it any consideration at this time.

In answer to Question No. 3, 24 State Boards, or 52 per cent, answered that no one other than a regularly licensed physician was permitted to practice the science of roentgenology. Notice this particularly, that while these 24 State Boards answered as above, in reality 18, or 39 per cent, of them do permit others besides regularly qualified physicians to practice roentgenology for the following carefully compiled reasons:

a. One state answered that only physicians were permitted to practice roentgenology, but several laymen were conducting laboratories and were reported as violating the law. Nothing was being done to prevent this, although I was asked what measures I could suggest to stop the practice.

b. Four states have no control in the matter.

c. Six states permit laymen to take and interpret skiagraphs but forbid them to give X-ray treatments.

d. One state permits osteopaths and chiropractors to use the X-ray.

e. One state allows only physicians to use the X-ray, but if others use it, no action is taken.

f. One state permits the practice of roentgenology by electro-therapeutists.

Answering Question No. 4, 25, or 52 per cent, answered in the affirmative and 17, or 37 per cent, in the negative. Seven, or 15 per cent, states consider the practice of

roentgenology as the practice of medicine only when treatment is given.

It is impossible to refute the fact that others besides licensed physicians are practicing roentgenology, and to permit this to continue will allow our beloved science to fall into disrepute.

How can we best prevent such a disaster? This is a question of sufficient complexity to tax the power of the wisest of us, and to "organized medicine" we must look for relief.

But simply to refer the problem to "organized medicine" is not sufficient. We ourselves must introduce more helpful policies, and take a keener interest in current events in order that legislation, when aroused, shall respond with stricter laws. This last is most necessary, for even a cursory examination makes it very clear that many states are extremely lax in the protection of the roentgenologist.

I am not an alarmist, nor is this situation a mere vaporing of the imagination. It is a reality. Because butchers are skillful with the knife, will the law permit them to operate upon the human body? To follow the application farther: If a layman is perhaps skillful in operating an X-ray machine, should the law permit him to practice medicine? You say "No," but many states say "Yes."

We are confronted to-day with a situation similar to that of physicians who specialize in bacteriology and pathology. Throughout this country, there are a large number of nurses and laymen making bacteriological and blood examinations, in many instances contrary to law. They have been permitted to do this kind of work for so long that it is almost impossible to remedy this vicious practice. Our situation is more hopeful and our success will be in proportion to the strength and persistency of our intelligent efforts.

In bringing this matter to your attention, there is nothing selfish in my motive, but I do believe in "rendering unto Cæsar the things which are Cæsar's," and surely a science which has been of such inestimable value to suffering humanity, even to the revolutionizing of medicine, is entitled to some protection.

LEON J. MENVILLE, M.D.

Herewith is presented the report of the Executive Committee and the Committee on Revision of Constitution and By-laws as read before the annual meeting of the Society held at Rochester, Minnesota, December 3 to 8, 1923. Other proceedings of this meeting will be presented in subsequent issues.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Rochester, Minn., December, 1923

During the past year it has been necessary for the Executive Committee to hold nine meetings besides the meetings during the annual and mid-annual conventions. A part of the work of the Committee was reported at the mid-annual meeting of the Society. Acting upon the authority given it at that time, the Executive Committee, with the Publication Committee, made arrangements for the publication in St. Paul of the official journal of the Society, RADIOLOGY. The September, October, November and December numbers have been published and mailed to the members of the Society and as many non-member subscribers as it has been possible to secure. The publication of RADIOLOGY has not been attended with any serious financial loss to the Society, the receipts for advertising and subscriptions, and the subscriptions for members of the Society having exceeded the cost of publication of every number except the first. A detailed financial statement will appear in the report of Mr. J. R. Bruce, the business manager of RADIOLOGY.

In September an action was brought in the District Court at St. Paul, Minn., by Dr. A. F. Tyler, a stockholder of the Radiological Publishing Company and a member of this Society, against the Radiological Society, the Bruce Publishing Company, Russell D. Carman and J. R. Bruce, asking

for an injunction restraining them from publishing RADIOLOGY or any other journal, and also asking that the Society be compelled to turn over its records and manuscript to the company. The hearing on the temporary injunction was held on October 30. The suit was successfully defended by the Society and the injunction was denied. The date of the trial of the suit for a permanent injunction is set for December 20.

The receipts from the sale of exhibit space at the St. Louis and Detroit conventions amounting to $3,730.00 which were collected by Mr. H. S. Tyler, in his capacity as business manager of the Society, have not yet been remitted by him to the Treasurer of the Society.

By agreement with the directors of the Radiological Publishing Company, the sum due the company for work done on the Research Bureau, the membership campaign, the Technician's Bureau and general administration in 1922, has been fixed at $2,466.46. However, the directors of the company having been denied access to their books, they have been unable to satisfy themselves that the money received by the former business manager for the sale of exhibit space has been turned over to the company, and therefore there has been no settlement of accounts between the two corporations.

Your Committee is glad to be able to report that in spite of the failure to collect the receipts for the sale of exhibit space in 1922, and the fact that the Society has incurred expense of necessary litigation during the year amounting to several thousand dollars, the financial condition of the Society is sound. The cost of holding conventions is less than the receipts from exhibitors. The publication of its own journal by the Society has already resulted in a small profit, and at the present rate of growth should yield an income several thousands in excess of expenses during 1924.

Your Committee would be unwilling to close its report without gratefully acknowledging the loyal support, co-operation and encouragement accorded it during a most trying year by the officers and members of the Society, the manufacturers, exhibitors and advertisers, and Mr. J. R. Bruce.

Respectfully submitted,

ARTHUR W. ERSKINE, Chairman.

DR. ERSKINE: I move that this report be received and placed on file.

The motion was seconded and unanimously adopted.

COMMITTEE ON REVISION OF CONSTITUTION AND BY-LAWS

Dr. Benjamin F. Orndoff, Chairman

Read before the first Executive Session, Monday, December 3, 1923

The Committee appointed last December has realized that the Society has grown rather rapidly and in going over the early Constitution and By-laws and the one under which we are now working a very marked change is evident. We also observed, as you undoubtedly all realize, that probably some further changes somewhere along the line are necessary. Whether it is an Eighteenth Amendment or a better diagnosis of the endocrine system I am not sure, but in any event we have gone into it seriously and realize that any change in the Constitution or organic law in a Society which is progressing as rapidly as this one, is in some danger. Therefore, Mr. Chairman, we beg to recommend that Article VI in the present Constitution, which reads as follows:

"Sec. 1. The Society authorized the formation of a company to be known as The Radiology Publishing Company, Incorporated.

"Sec. 2. The Company and its stock shall be owned and controlled entirely by members of the Society.

"Sec. 3. The Company shall take charge of the proceedings of the Society except as hereinafter provided," BE REPEALED, and that the rest of the Constitution be adapted, by the necessary minor changes, to the fact that this Section has been repealed.

Dr. Trostler moved that the report be received and that the changes recommended

by the Committee be the first matter of consideration at the next Executive Session. Seconded by Dr. Soiland and unanimously carried.

DR. ORNDOFF: In order to save time and after conference with many of the officers and members of the Society, and in addition to the report relative to the Constitution under which we are now working, this Committee begs to offer a more complete revision of the Constitution with the view that such a constitution is probably better adapted to the possible future of the organization. With your permission, Mr. President, I would like to read this constitution with the idea that if a new constitution shall be your choice to-morrow, when the matter will be decided upon, you will be conversant with the text. We are to decide whether we shall adopt a new constitution or a revision of the old one and unless this is read it cannot be considered to-morrow.

Upon permission from the Chair, Dr. Orndoff read the Constitution and By-laws prepared by the Committee on Revision.

As this completed the business for the time on motion duly seconded the Executive Session adjourned at 1:30 P. M.

SECOND EXECUTIVE SESSION, TUESDAY, DECEMBER 4, 1923

COMMITTEE ON REVISION OF CONSTITUTION AND BY-LAWS

Dr. Benjamin H. Orndoff, Chairman

DR. ORNDOFF: The Committee has been in conference * * * * and wishes to submit the first portion of the report of yesterday in regard to the Constitution under which we are now working, especially in regard to Article VI, which we recommend be repealed.

We also recommend that there be several other minor changes in the Constitution and By-laws, and therefore I move that the repeal of Article VI be voted upon section by section by the Society in Executive Session assembled.

Motion seconded by Dr. Soiland and unanimously carried.

Dr. Herrick moved that Section 1 of Article VI be repealed by vote of the Society. Seconded by Dr. Trostler and carried.

Dr. Herrick moved that Section 2 of Article VI be repealed by vote of the Society. Seconded by Dr. Poyntz and carried.

Dr. Herrick further moved that Section 3 of Article VI be repealed by vote of the Society. Seconded by Dr. Hubeny and carried.

Dr. Herrick then moved that Article VI in its entirety, Sections 1, 2 and 3, be repealed by vote of the Society in Executive Session assembled. Seconded by Dr. Trostler and carried unanimously by rising vote.

DR. STEVENS: It seems to me that we should specify each of the necessary changes in the different articles in order to make them conform to the changes made in Article VI. I think Dr. Orndoff has a list of them and I move that he submit them to us at this time. Motion seconded by Dr. Ullmann and carried.

Dr. Orndoff then presented and recommended the following changes in the Constitution:

Article II, Section 3, to read: "To maintain a journal."

Article V, Section 5: "The words 'of Radiology' deleted so that it now reads: 'The President upon assuming the duties of his office, shall appoint his committees and present a record thereof for publication in the next issue of the journal.' "

Article V, Section 8: "The word 'journal' to be spelled with a small 'j' in two places mentioned so that it now reads:

" 'The Librarian shall endeavor to provide safekeeping for all records and transactions of the Society, which possess historical value; file and hold subject to reference by the members of the Society, all books and other manuscripts received by the editor and reviewed in the journal; receive and maintain all volumes of the journal; provide proper curation and safekeeping of such museum specimens as he may find it possible to obtain; prepare and exhibit at the annual meeting, such articles as he considers advisable; file and list such lantern

slides and other articles for reference by the members as in his judgment may be of value. He shall present a yearly report at the annual meeting of the Society.' "

Dr. Herrick moved that these minor corrections by agreed to by a vote of the Society in Executive Session assembled, and that the Constitution be amended in the manner specified. Seconded by Dr. Trostler and unanimously carried.

Dr. Orndoff then presented and recommended the following changes in the By-laws:

"Article II, Section 2, delete the words 'Journal of Radiology' and substitute 'journal' at the end of the clause."

"Section 3, the words 'Journal of Radiology' to be deleted and the word 'journal' substituted."

Article III, Section 1 (a), was changed so that it now reads: "There shall be a publication committee consisting of three members who shall be appointed by the President of the Radiological Society of North America, and who shall serve for a term of three years; one retiring each year. Upon the organization of the Committee the President shall appoint one member to serve for one year, one to serve for two years, and one to serve for three years. The President shall designate who shall be Chairman of the Committee for the first and second years; thereafter the senior member shall be chairman. In case of vacancy, the President shall appoint a member to serve the unexpired term of the member vacating his place on the Committee."

Dr. Herrick moved that the changes recommended in the By-laws be agreed to by a vote of the Society in Executive Session assembled, and that the By-laws be amended in the manner specified. Seconded by Dr. Soiland.

A SECTION OF RADIOLOGY IN THE AMERICAN MEDICAL ASSOCIATION

To the Editor of RADIOLOGY.—A number of letters and inquiries have reached my desk concerning the proposed Section of Radiology in the American Medical Association. I am, therefore, taking the liberty to ask you to print this statement of events and facts.

Last year a bill was passed by both houses of the California State Legislature authorizing laymen to establish and operate X-ray laboratories for medical purposes. Only by a supreme effort of California's medical radiologists was the governor induced to withhold his signature, and for the time being radiology was saved for the medical profession. While to us radiology is the highest type of medical practice, yet it is not generally recognized as such, even in certain higher medical circles. In order, therefore, to seek a remedy and to secure the aid of the largest organized scientific medical body in the world, I appealed to the American Medical Association.

At the San Francisco session of this body, acting as an accredited delegate for California, I prepared and presented a resolution to the House of Delegates of this body, asking them, first, to recognize radiology as an integral part of medicine and surgery and, second, to create and establish in the American Medical Association, a Section on Radiology. The House voted unanimously to recognize radiology as an integral part of the practice of medicine and surgery, but declined to recommend the creation of a new Section. Being convinced that a Section of Radiology in the American Medical Association would encourage medical legislative help and further the cause of the broad science of radiology, I made application to the Council of Scientific Assembly to use the Section of Miscellaneous Topics for a tentative Section on Radiology. With the kind and courteous help of Dr. Olin West, Secretary of the American Medical Association, I was instructed as to the parliamentary proceedings necessary to accomplish this purpose.

In order to make a few points clear, I want, first, to assume all responsibility for this present movement to create a Section in the A. M. A.; second, to state that the object of this movement is to safeguard and

perpetuate the science of radiology to the medical profession; third, to propose that the Section of Radiology in the American Medical Association, if successfully established, be not the property of any clique, faction, group, or society. It is intended to be the fraternal campus for every Fellow of the American Medical Association interested in radiology.

The officers of the temporary Section for the present year, as selected by the Chairman of the Council on Scientific Assembly of the American Medical Association, are: Willis Manges, Philadelphia, Chairman; Albert Soiland, Los Angeles, Vice Chairman; M. J. Hubeny, Chicago, Secretary.

The Council of the American Medical Association met in Chicago, December 21, and it was necessary to have all data in their hands, including suggestions for officers and a comprehensive tentative program, with titles and authors. Being in Chicago at this time, and having only a few days to spare, I secured the aid of Doctors Orndoff and Hubeny, both radiologists of Chicago, and in close touch with American Medical affairs. We made a hurried campaign and secured the necessary papers from as representative a field as could be reached in the brief time allotted. This program is now in the hands of Chairman Manges, and will, I think, be attractive enough to draw a great many medical men to our cause who have formerly been temperamentally or otherwise indifferent.

When you register at the American Medical Association at Chicago in June, please write *Radiology* under your name. There is, as yet, no provision for this Section.

Respectfully submitted,

ALBERT SOILAND.

A CORRECTION

In the January issue of RADIOLOGY, in an article on the Scientific Exhibit at the Rochester meeting of the Society (page 48), the name of Dr. Maurice A. Loebell, of Zanesville, Ohio, was incorrectly spelled. Dr. Loebell exhibited a very ingenious marker for films or plates made with an ordinary typewriter on florist's foil, and we regret the unintentional error in printing his name.

—THE EDITOR.

PRELIMINARY NOTES REGARDING SUMMER MEETING

Pacific Coast members will be glad to learn that there has been a summer excursion rate established between all Pacific Coast points and Chicago, effective May 22nd to September 15th, inclusive, limited for return trip to October 31st, with stopover privileges at all points either going or coming. The rate will be $86.00 for round trip to Chicago and return.

There will be the usual one and one-half fare for round trip on the certificate plan, effective from all over the U. S. and Canada, and summer tourist rates to Chicago and return from nearly all over the West, Southwest, and Northwest.

The Committee of Arrangements is planning something different in the amusement line for those who attend the Chicago session. Particulars will be given later. Plan to attend and enjoy the best time you have ever had at any meeting I. S. T.

The memory of Professor Roentgen has been honored by the University of Würzburg in the founding of a museum bearing his name and also in the placing of a portrait bust of the scientist in the Physical Institute, where, in 1898, he announced his discovery of the rays which bear his name. A boulevard in the city has been given his name as well.

The organization of the Milwaukee County Roentgen Society took place at Milwaukee, Milwaukee County, on Feb. 1, 1924. The membership embraces the roentgenologists of Milwaukee County, together with associate and honorary members, taking in the larger part of the medical profession.

The object of the Society is not only to place roentgenology as a specialty, but to promote the science by educational propa-

ganda and closer relationship with the entire medical profession.

The following officers were elected after the adoption of the constitution: Dr. F. W. Mackoy, President; Dr. H. B. Podlaski, Vice-President; Dr. C. W. Geyer, Secretary-Treasurer.

The Society will meet on the first Friday of each month.

A letter received from Dr. A. E. Barclay, of Manchester, England, states that it is proposed to open the British Institute of Radiology about July 3rd with a two days' congress. Following this there is to be a physicists' evening at Oxford, the Mac-Kenzie Davidson lecture either at Oxford or Stratford, and a day each in Manchester, Liverpool, and Edinburgh. Possibly the tour will be made by motor.

It is with regret that we announce the death of Dr. Ralph Walter Mills, of St. Louis, Missouri. His activities were numerous and worthy of especial mention, which will be made in the April issue of Radiology.

BOOK REVIEWS

DENTAL INFECTIONS, ORAL AND SYSTEMIC: VOLUME I, RESEARCHES AND FUNDAMENTALS, DENTAL INFECTIONS AND THE DEGENERATIVE DISEASES; VOLUME II, CLINICAL RESEARCHES, BY WESTON A. PRICE, D.D.S., M.S., F.A.C.D. THE PENTON PUBLISHING COMPANY, CLEVELAND, OHIO.

A little over fifteen years ago, the world of healing arts and sciences experienced a seismic cataclysm. Hunter caused most of it undoubtedly. To-day we realize that dental dust and ashes and the traditions and empiricisms of the ages as touching oral pathology and its treatment were hurled skyward, until the source of light and life was obscured and dental darkness was upon the face of the whole earth. Since that time these elements of practice have been kept from settling by the various winds, trades, counter-trades, simoons, typhoons, from opinionated men, who, from real research laboratory work, knew whereof they spoke.

We have long needed an authoritative word. The medical branch of the healing art, as well as the dental branch, is really anxious for a statement based upon research that will set at rest so many moot questions as are raised concerning dental infections.

In these two volumes, Dr. Price, the author, has gathered together the facts and conclusions of his very exhaustive researches in oral infection problems. The twenty-five years of labor the author has spent in this work makes all mankind his debtor. Without reservation, we recommend these two books to the open-minded and studious.

From the literary viewpoint they are characterized by clearness, perspicuity and precision. One gets the impression that the writer is very familiar with the facts presented and that he is competent to say what he says, the result being that it rings true. The subtlety with which the new truths are presented, unwittingly it would seem, demonstrates the old adage's truth, viz., knowledge is power. There is some reiteration, but this is excusable as the author evidently wishes to keep the reader mindful of what has preceded and thus enable him the more easily to draw his own conclusions.

To the medical profession, possibly a little more emphatically than to the dentists, we would recommend a careful reading of the chapter on oral roentgenograms. Ocular evidence is demanded by physicians, usually, and films in which there is no sign of the reaction of the host to the invader usually interest them not at all. The reader will have his attention called to the facts concerning such misleading means of diagnosis. The author is anxious, with the new truths presented in these volumes, to develop a new sense—the dental infection sense.

To all, the chapters on susceptibility will surely make an appeal. Again and again throughout the work repeated reference to this very important phase of our problem recurs. This is well, for acquaintance with the susceptibility factor—absent, acquired, and inherited—must go hand in hand with the dental roentgenograms as a determining factor in diagnosis and procedure. Susceptibility in the succeeding chapters is maintained, although somewhat subrosa, as an ever-present concept.

The author's discussion of the blood calcium, —ionic, physiologically, and pathologically combined,—is made so clear that even though the reader may have forgotten a great deal of his chemistry, yet he gets nearly the full signifi-

cance of the text, and is incidentally led to renew his interest in this fundamental subject. The same might be said of the presentation of the importance of maintaining the proper alkalinity balance. The criticism possible here might be in the brevity of discourse, though an ample bibliography is to be found for those desiring to pursue this phase further.

There is a discussion of forty-five problems in Volume I, all of them vitally important to the practitioner. Here is one selected at random: Problem: Is the danger proportional to the evidence of absorption of bone about the apex of the suspected tooth? Dr. Price's answers and conclusions to all of these problems are based upon a long and arduous series of experimental procedures. All kinds of paraphernalia and apparatus necessary for such work is and has been at his command. This has enabled him not only to give definite answers to these pertinent problems, but it also has enabled him to range side by side the old and new interpretations as a guide.

The books are well indexed. The bibliography given is very complete. All in all, as the demands of the day are for more light on all our endeavors, especially in a surgical and therapeutic line, it would be hard to conceive of a more valuable addition to a professional library. There will be very little doubt left in the minds of readers of these books as to what ought to be done. They deal with the facts and problems of every-day practice. They deal with the conditions as we find them; not as they ought to be, but as they are.

The books are not radical; they are rational. They are not red, neither are they yellow; but they are true-blue. They are not destructive, save incidentally; they are constructive. The author seems to realize that Nature hates a vacuum as well as an iconoclast, so he has constructed a new system, a new sense; first, so that when the professions of which he is so fond get the proper perspective they will move out of the old shack and immediately take up their abode in the new edifice whose cornerstone is health. Looking at the practice of dentistry as it is to-day, aided and abetted by a great many members of the medical profession, and then in turn looking at the results of his experiments and studies, Dr. Price, prior to submitting his findings to writing, must have had some such thoughts as these:

I write not what mine enemies deserve, but what I must, to preserve my own self-respect.

C. F. B. Stowell, D.D.S.

Interpretation of Dental and Maxillary Roentgenograms, by Robert H. Ivy, M.D., D.D.S., F.A.C.S., and Le Roy M. Ennis, D.D.S. Second ed., revised and enlarged, 403 illustrations. C. V. Mosby Co., St. Louis, 1923.

The book is rather elementary and would do for students, etc. The reading matter is short and not unduly drawn out, yet a note of conservatism is evident. Much might be said about the four hundred illustrations, there being a few good reproductions. The majority, however, are hardly of the type which give us any information. The publisher has apparently taken great pains with the mechanical side of the publication and has spent considerable time and money in getting the book up as attractively as possible on high quality paper with rather expensive cuts. The difficulty seems to lie in the fact that many of the original roentgenograms are not of a caliber which make for good reproductions, and in a few instances, were it not for the fact that an arrow indicates the pathology which the authors desire to show, one would feel at a loss to know what the picture represented. As a whole, the book is worth while adding to the student's library but does not offer anything new over what has previously been published.

Robert A. Arens, M.D.

ABSTRACTS OF CURRENT LITERATURE

Cardiac examination.—The technic of finding the "index of depth" of the cardiac shadow is described. At a 60 cm. target screen distance the shift of the extreme left margin of the heart is noted for a displacement of 10 cm. of the tube. From the shift on the fluoroscopic screen the actual depth of this point from the anterior chest wall can be determined. The "angle of disappearance of the apex" is determined by rotating the patient slowly with the right shoulder as a pivot, the left shoulder gradually becoming more distant from the screen. When the apex of the heart disappears behind the spine the angle which the thorax makes with the screen is determined by the goniometer, an instrument devised for this purpose. Theoretically, the angle of disappearance of the apex should depend normally to a great degree on the shape of the thorax. Clinical observation also shows a marked variation in the individual, with quiet respiration, forced inspiration and forced expiration. Observations were made on practically all deformities of the cardiac shadow incident to various valvular lesions and a comparison of this method of study with the older, more generally used cardiothoracic ratio—relation of

thoracic to cardiac measurements. It was found that the two methods could not be considered in any way as parallel and must be used in association with each other.

Conclusions as stated by the author are as follows:

1. There is no harmony between the "index of depth" and the "angle of disappearance of the apex."
2. There are normal cases in which the angle exceeds quite definitely the upper normal limit (40 degrees) of Bordet and Vaquez.
3. Normally the index does not exceed 16 mm.
4. There are undoubtedly cases of enlargement of the left ventricle in depth with a normal index.
5. It is quite obvious from the above findings that the index is of value only in a positive direction.
6. The most important factor influencing the index measurement is the shape of the left ventricle.
7. When from the anteroposterior fluoroscopic or plate examination it is difficult to differentiate between a heart with an aortic valvular lesion and one with hypertensive disease, an index measurement of 25 mm. or more is very suggestive of the latter affection.
8. The index may be a very valuable additional method for studying the progress of hypertrophy of the left ventricle in an individual case.

L. R. SANTE, M.D.

Some Observations on the Value of the Index and Angle of Bordet-Vaquez in Cardiac Examination. D. S. Dann. Arch. of Internal Med., Feb., 1923, p. 269.

Irradiation of deep-seated lesions.—O'Brien reviews the recent literature on the irradiation of deep-seated lesions. To-day the attempt is made to use only X-rays of extremely short wave lengths, monochromatic or homogeneous radiation. Such quality of X-radiation is developed only at very high voltage. To say that nowadays X-ray machines are in use that develop 300,000 volts, triple the capacity of the machines of five years ago, and that treatments are given lasting twelve hours at one sitting, may help to visualize the tremendous change in method. The destruction of the tumor tissue, by means of the radiation absorbed in it, is the underlying principle of this new development in X-ray therapy. X-rays of long wave length produced at low voltage—the so-called soft rays—burn the skin and do not penetrate deeply. X-rays of short wave length—the so-called hard rays—penetrate deeply and do not have the same tendency to burn the skin.

It is well known that when X-rays come in contact with matter, secondary X-radiation is set up. These secondary X-rays within certain definite limits appear to affect the tumor mass much as the X-radiation of the primary beam; and, unless considered, can introduce an error of as high as 50 per cent when estimating dosage by the absorption method.

While the biophysics of the X-ray has been much investigated, what seems to be needed now is a more intensive study of the biological effects of X-rays, a better knowledge of tumors and of the mechanism of bodily defense and repair.

European practice has not hesitated to give intensive treatments at one sitting, lasting six, ten and twelve hours. Some in America who have tried to copy this method have reported excellent results as to the disappearance of malignant growths, but the patient has also disappeared. In two cases of inoperable cancer of the breast, recently reported, there was almost miraculous atrophy of the tumor mass, but both patients developed a massive pneumonia or pleural exudate consequent to the inflammatory reaction produced by the X-rays, and promptly died. Untoward results may be explained partly on the score of inexperienced operators using data similar to but not identical with that of the originators of a particular line of treatment, and also on the nature of the tumor and the roentgenologists' unfamiliarity with it.

The reports of good, bad and indifferent results with the new mode appear to parallel the history of cancer therapy. Malignant tumors with glandular involvement at least do as well with intelligently applied X-ray therapy as with surgery. A primary tumor removed surgically is often followed by disastrous results, but when absorbed slowly under radiation may yield some increased immunity to the body.

Opitz, reviewing his own work and that reported by others, made the observation that the best curative results were obtained with repeated irradiations in which the so-called "carcinoma dose" of intensive therapy was not attained. His conclusions agree with those of Ewing in this country.

Many writers on X-ray therapy give the impression that the chief thing to have in mind is the lethal dose, one that kills the cancer cell. But, as Opitz says, it would be unreasonable to assume that cancer cells should behave differently than other tissue cells which all can be changed or destroyed by the rays, depending on the amount of rays administered. Opitz, like many others, believes the explanation of the curative results, in radiation of malignant growths, is to be found in the actuation of the defensive forces which are formed in the neigh-

boring tissues as well as elsewhere in the body by the action of the rays, and not in the direct action of the rays on the tumor itself. He concludes that too intensive radiations may destroy the defensive material furnished by the lymphocytes and lead to a general impairment of the body which weakens the hematopoietic organs. Besides these local effects of irradiation there is the general or systemic effect which must be considered, such as increase of blood pressure due to the action of the rays on the suprarenals, pancreas and spleen.

It would seem then that while death of all cancer cells by irradiation would be ideal, it is impossible of accomplishment at all times by any known form of radiation. The effort should not be made to irradiate up to a lethal dose because of the very grave danger to biological processes essential to repair. To speak of a "carcinoma dose" as a physical constant is a fallacy, because of the variability of response of different types of tumor cells to irradiation. Repeated relatively small doses of X-rays are to be preferred to so-called intensive therapy of long duration at one sitting, because of the stimulative effect on the lymphocytes and connective tissue and general beneficial systemic effect.—*The Present Mode of Roentgen Therapy in Deep-seated Lesions. F. W. O'Brien. Boston Med. and Surg. Jour., July 5, 1923, p. 1.*

Treatment of closed fallopian tubes.—Kennedy, in endeavoring to locate the site of obstruction in or about the tubes, fills the uterus with a 20 per cent solution of sodium bromide under pressure and then radiographs that portion of the genital tract which has received the fluid. The ampulla of the tube rendering a shadow must be connected with the uterus by a patent isthmus, even though the passage between contains no sodium bromide. If the ampulla of the tube does not appear on the radiograph, an obstruction must exist in the isthmus of the tube or in the cornu of the uterus or the tube has been previously removed. Eighteen cases with occluded tubes are described, as well as the technic of filling the uterus under pressure.

No radiogram should be made in any case where there is evidence of bleeding.

Radiograms obtained according to Kennedy's method when one or both tubes are patent or partially occluded show: (*a*) that probably one tube is open when practically all the sodium bromide solution is seen in that side of the pelvis; (*b*) that when the cervix is tightly closed the uterus and tube (or tubes) completely empty their fluid contents into the peritoneal cavity.

The information obtained from such radiograms determines the following points for the surgeon before opening the abdomen:

(*a*) The length, breadth, position and direction of the canal of any tube casting a shadow.

(*b*) The exact site of the occlusion, whether at the fimbria or in the isthmus.

(*c*) Whether a tube, open at its isthmus and closed at its fimbria, is empty and simply clubbed, or is filled with fluid such as hydro- or hemato-salpinx.

(*d*) Whether an operation to overcome the obstruction and thus remove sterility might hopefully be done when at least one isthmus is open, or might be almost useless when both isthmi are closed.

In the case of a sterile woman having no active cervical or tubal involvement, a study should be initiated with the carbon-dioxide method of Rubin. If an occlusion is determined the uterus and both tubes should be radiographed by the above method to determine the points of occlusion and indicate when operation ought to be done.—*Radiography of Closed Fallopian Tubes. W. T. Kennedy. Amer. Jour. of Obst. and Gyn., 1923, VI, 12.*

Fibromyoma of the uterus.—The author says that radiotherapy has saved about 50 per cent of those needing treatment for fibromyoma of the uterus from major operations. In the present paper he deals with factors which in such conditions rule out radiotherapy and indicate operation.

Before applying radiotherapy in an individual who is a good operative risk the diagnosis must always be nearly absolute and there should be no divided responsibility as regards diagnosis.

Extra-uterine neoplasms and malignant growths of the uterus must be excluded. Chronic adnexal inflammation, so light as to escape diagnosis, need not be a deterrent.

Symptoms of toxemia, anemia unexplained by loss of blood, local pain, tenderness, change in consistence of the tumor, rapid growth, and large size may indicate inflammation, degeneration or sarcomatous change and demand excision.

Of the symptoms associated with myoma, bleeding due to ulceration or blood vascular disease may not cease with the onset of the menopause. In the author's experience all other bleeding will. Pain associated with menstruation will cease, but pain occurring at other times may not. Urinary disturbances are not well relieved.

Shrinkage of a myoma will almost always follow adequate doses of radium and X-ray, but the discomforts of the dosage necessary, coupled with the potential danger in the large mass, make operation preferable.

Doses of radium and X-ray, insufficient to induce a menopause, are unsatisfactory. The mass may fail to shrink. The effect of the bleeding is uncertain. The mental reaction of the patient is bad.

Hot flashes are constant and slight increase in

nervous irritability is frequent after radiotherapy. The former are not important. The latter demands caution in using the method in women who show any mental abnormality.

Child-bearing is possible after radiotherapy. Radium should never be used in a woman who may become pregnant. The sclerotic changes predispose to dystocia. Besides, the X-rays may disturb the structure of an ovum and determine abnormal structure or development of the fetus. Radiation should be used only where hysterectomy is the only alternative.—*The Limitations of Radiotherapy in the Management of Fibromyoma of the Uterus. J. A. Corscaden. Amer. Jour. of Obst. and Gyn., 1923, VI, 42.*

To determine the divergence of rays.—The many mistakes in interpretation of X-ray plates due to the distortions caused by the divergence of rays coming from a single point, have led to the development of a measuring device which enables the source of error to be controlled.

The device described by the author, which is fully illustrated, consists essentially of a metal base in contact with the plate and holding a millimeter scale with opaque markings, with a standard from which two adjustable arms project. These carry at their ends metal plates exactly 1 cm. square. The instrument is employed by placing the base with its scale upon the plate container and raising the arms to an appropriate distance, determined by the particular part to be studied. Thus in radiographing a wrist, one metal plate is adjusted to the upper surface of the styloid. The subsequent enlargement of the square on the radiograph indicates the enlargement which occurred in these structures lying at the level of the metal square. Calipers applied to the squared area lead immediately to the determination of enlargement and this enlargement in turn may be used as the base-line of a truncated cone for the measuring of any intervening tissues. To determine whether the tissues are in any way affecting the steel measuring square, one arm may be placed above these tissues and the other swung off at the same level but with only the second square between the target and the plate.

The illustrations are accompanied by figured mechanical drawings which will enable any roentgenologist to have the apparatus constructed correctly.

The usefulness of the instrument described is in no way dependent on the time element so necessary in the diaphragmatic devices used for this purpose up to the present, and there is no complicated synchronism between the length of exposure and the movement of the diaphragm. —*An Instrument for Measuring Distortion Due to the Divergence of X-rays. E. C. Hill. Johns Hopkins Hosp. Bulletin, May, 1923, p. 164.*

Surgery and radium in uterine cases.—Danforth thinks that irradiation for bleeding of uterine origin is distinctly a form of therapy which should be directed by the surgeon rather than by the radiologist. The indications for radium in the case of women in the decades prior to the climacterium should be quite clear before using it. In women under forty the complete inhibition of ovarian function, which the usual dose for myopathic bleeding brings with it, may have consequences which are more serious than the disease which it is intended to eradicate.

All cases giving a history of pelvic infection should be excluded, as application of radium may be followed by recurrence of the infection.

The author has further limited the use of radium to fibroid uteri which are not larger than a two and one-half to three months' pregnancy. The larger fibroids are better removed surgically. Full dosage of 1,000 to 1,200 milligram hours is employed by the author only in cases of women over forty years old. There was no mortality nor morbidity in this series.—*The Treatment of Benign Uterine Hemorrhage by Irradiation. W. C. Danforth. Amer. Jour. of Obst. and Gyn., 1923, VI, 172.*

Distinction between eventration and hernia of the diaphragm.—Two cases of this rare anatomical anomaly, both children, are presented, with the same findings. There is a high-lying diaphragm on the left side, with the stomach, spleen and large bowel occupying the space usually filled by the lung. The heart is in the right chest. The stomach is large. The large bowel is also dilated and enlarged. The liver is vertical and right-sided. The chest wall shows a slight bulging of the lower half of the left side. This condition was designated by Cruveilhier as eventration of the diaphragm. Both cases are well illustrated by radiographs taken to establish the diagnosis. Cruveilhier, in 1849, credited J. L. Petit with having described this condition, found at autopsy, while numerous others have since described the condition and cited cases. The condition is rare, however. When these cases are compared with hernias of the diaphragm, we find, according to Struppler, that there are forty-four eventrations to five hundred hernias of the diaphragm. X-ray is the chief method of diagnosis. Only eight cases of eventration were described before the use of the X-ray—since then forty-one have been reported as diagnosed by the X-ray.

The condition is probably congenital. It occurs nearly always on the left side and where autopsy reports are available the lobes of the lung are both present on this side but are very small.

The chief confusion in diagnosis will be with diaphragmatic hernia. As both conditions may be congenital and both exist for a long time without symptoms, it is often impossible to distinguish between the two conditions without a thorough X-ray study. The continuity of the arch of the diaphragm in eventration or displacement marks the distinction from hernia, which, whether congenital or traumatic in origin, shows an irregularity in the diaphragm, and the mottled appearance of the lung may show through the gas contained in the stomach.

The diaphragm moves with respiration but the excursion may be much reduced owing to the congenital hypoplasia of the left lung. In diaphragmatic hernia a "paradoxical expiratory displacement" has been noted, the diaphragm descending when it should ascend in the normal phase of respiration.

L. R. SANTE, M.D.

Eventration of the Diaphragm. M. B. Clopton. Ann. of Surg., Aug., 1923, p. 154.

Coagulation of the blood.—Stephan was the first, in 1920, to draw attention to the action of the roentgen rays upon the coagulation of the blood and to the therapeutic importance of this action. He thought that the effect was due to the excitory action of the rays on the reticuloendothelial apparatus of Aschoff. According to American research the mechanism of the coagulation changes according to the particular area, splenic, hepatic, or intestinal, which is irradiated. Stephan irradiated the splenic area alone.

The authors have made a number of experiments in order to study:

1. The action of the roentgen rays from the point of view of acceleration of the coagulation, the determination of the minimum dose to produce a clear acceleration, and of the maximum dose starting from which the time of coagulation remains constant. In this series the splenic area alone was irradiated.
2. The action of the rays on the circulating blood.
3. The action of the rays on the blood *in vitro*.
4. The beginning and the duration of the modifications of coagulation after irradiation.
5. The existence of any immunity to the roentgen rays.

With a dose of 500 R the time of coagulation which before irradiation varied from 4 min. to 7 min. 30 sec., descended, after irradiation, to from 2 min. 55 sec. to 5 min. 40 sec. In the 10 human subjects investigated shortening of the time of coagulation was notable in the majority, but there was none in two.

The minimum dose to obtain acceleration of coagulation was about 100 R (0.5 H), but 500 R was usually employed in the experiments.

Irradiation of other areas than the splenic also demonstrated a very marked shortening of the time of coagulation.

As regards the effects upon the blood *in vitro*, the authors' experiments have not shown any acceleration of the coagulation after irradiation whether the blood was citrated or oxalated or without chemical addition. The effects of irradiation as regards coagulation do not therefore seem to be due to any action exercised directly upon the blood itself.

The acceleration of coagulation under the influence of the roentgen rays is very rapid and may be observed in many cases in from 5 to 10 min. after irradiation.

In regard to immunity to the roentgen rays the facts have shown the authors clearly that there is an undoubted immunity at least for the usual dosage. A dosage producing a considerable acceleration in a first application no longer produces an acceleration when a second application is made 8 to 11 days following the first, but the acceleration reappears when applications are made at long distances from each other.

The authors' experiments have shown the existence of an acceleration of the coagulation which is nearly always positive, though a few cases show a retardation of coagulation. The acceleration is produced rapidly after the irradiation and ceases to be effected after a time which varies with the subject for the same dosage. The acceleration is demonstrated after irradiation of the splenic region and of regions provided with large trunk arteries.

These accelerations of coagulation explain the sedation, often rapid, of uterine hemorrhages in the treatment of fibroma of the uterus after initial irradiations. They also explain the favorable results obtained in the treatment of hemorrhages in hemophilia and justify the therapeutic use of irradiation of the spleen in order to obtain a rapid hemostatic effect.—*Action of the Roentgen Rays upon the Coagulation of the Blood (Action des rayons de Roentgen sur la coagulation du sang). Pagniez, Ravina, and Solomon. Jour. de Radiol. et d'Electrol., April, 1923, VII, 153.*

Cancer of the cervix.—The two underlying principles which are of primordial importance in the radiotherapy of cancer are: the existence of a radiation dose excitatory for cancer, and the rôle of the specificity of the wave length in the regression of neoplasms.

The author gives a number of reasons and opinions to show that dosage of X-rays or of radium, insufficient to cause degeneration and death of the neoplastic cells, may, however,

stimulate their growth. A neoplasm is capable of receiving an excitatory or stimulating dose:

1. When the quantity of X-raying incident on the skin has not been measured with sufficient exactitude and has been of too short duration.

2. When, in irradiation with a single field, the cell is too deeply situated in relation to the skin to receive the cancericidal dose.

3. When, in the treatment of deeply situated cancers and in the course of the cross-fire method, the neoplastic cell, owing to the technical errors, does not receive the summation of the doses intended for it.

4. When, in cases in which large cutaneous surfaces are to be irradiated as in cancer of the breast, small fields are selected leaving dead spaces between them instead of large uniform fields.

5. When, in the employment of very large fields at great distance, special dispositions are not made to equalize the doses throughout the area of the field.

Consideration of the foregoing will explain why contradictory results are obtained by different radiotherapeutists. Timid radiotherapy, insufficient apparatus, defective technic, with insufficient dose of X-rays or radium, end not only in failure but in disaster.

The author shows graphically why radium, when not properly employed, can entirely sterilize early well localized cancer, but in cases where the cancer is propagated the cells disseminated in the ligaments and hypogastric ganglia are placed at an optimum distance to receive only a stimulating dosage. The advantage of the X-rays, capable of giving very homogeneous raying over large areas, is therefore very clear. The quantitative advantages are, however, so to speak, offset by the specific action upon the neoplastic cell, which appears to be less with the X-ray than with the gamma ray of radium.

The author enters into a long technical discussion of the application of the principles alluded to above in the treatment of cancer of the uterine cervix and from which he draws the following conclusions:

1. In spite of the recoveries attributed to the X-rays alone owing to the specificity of the gamma radium rays, it does not seem to be yet authorized to give preference to treatment by rays of very short wave-length alone rather than to radium therapy.

2. By reason of the purely local curative action and sometimes of the excitatory action of radium at distance there is no right to practice radium treatment of the uterine cervix without immediately following it by large irradiations of penetrating radiotherapy.

3. Each of these two methods (which ought to be combined) when employed alone risks, the X-rays of sometimes failing in local specificity, and radium of being insufficient and even dangerous at distance.

4. The results obtained up to now justify the hope that recoveries will be more numerous according as the apparatus and technic of roentgen therapy will permit of giving homogeneous irradiation over wider areas, the degree of penetration of which rays will more and more approximate the gamma rays of radium.

Coliez remarks that in France treatment of cancer of the uterine cervix by radium alone has been widely practiced. There is no question of discussing the high efficacy of the gamma rays of radium. Cases treated in the initial phase appear actually after four or five years to be completely cured and in the case of inoperable patients many have been improved to the extent that they have become operable. However, in certain cases, and particularly in the spinocellular, after a period of remission which is often very considerable, and an appearance of complete recovery, metastases are seen anew which rapidly increase to great volume and lead to cachexia and death. Certain authors have affirmed even that metastases are more frequent after radium than after operation. It would therefore seem, which is conformable with the idea of excitation, that after its local action, however beneficial, but which does not seem to surpass 3 cms. around each utero-vaginal tube, that in the more distal regions (broad ligaments, etc.) there is marked development of the neoplasia. Treatment of cancer of the cervix uteri by radium therapy alone is compared to the old limited hysterectomy.—*The Physical Bases of Irradiation of Cancer of the Cervix by Combined Radiotherapy and Radium Therapy (Les bases physiques de l'irradiation du cancer du col utérin par la curiethérapie et la radiothérapie combinées). R. Coliez. Jour. de Radiol. et l'Electrol., 1923, VII, 201.*